DOCUMENT RESUME

ED 223 619 TM 820 307

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TITLE Science Library of Test Items. Volume Seven. Comprehension Testing Programme. Part 2: Print Masters for Reproduction (Exercises 1-63).
INSTITUTION New South Wales Dept. of Education, Sydney (Australia).
REPORT NO ISBN-0-7240-4454-X
PUB DATE 80
NOTE 105p.; The Library of Test Items series includes ED 218 284-299, TM 820 303-321, and TM 820 892-895. For related documents, see TM 820 306 and TM 820 314-315.
PUB TYPE Tests/Evaluation Instruments (160) -- Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01/PC05 Plus Postage.
DESCRIPTORS *Diagnostic Tests; Foreign Countries; *Reading Comprehension; *Science Tests; *Scientific Literacy; Secondary Education; Secondary School Science; *Test Construction
IDENTIFIERS *Assessment Instruments; *Australia (New South Wales)

ABSTRACT

Print masters for the reproduction of 63 exercises in diagnostic and formative testing of science comprehension skills are provided. Passages from science periodicals and general texts are presented with items to test vocabulary, content and conceptual comprehension. Research questions are included in the program for use in grades 7 through 10. (CM)

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SCIENCE

LIBRARY OF TEST ITEMS

Comprehension Testing Programme

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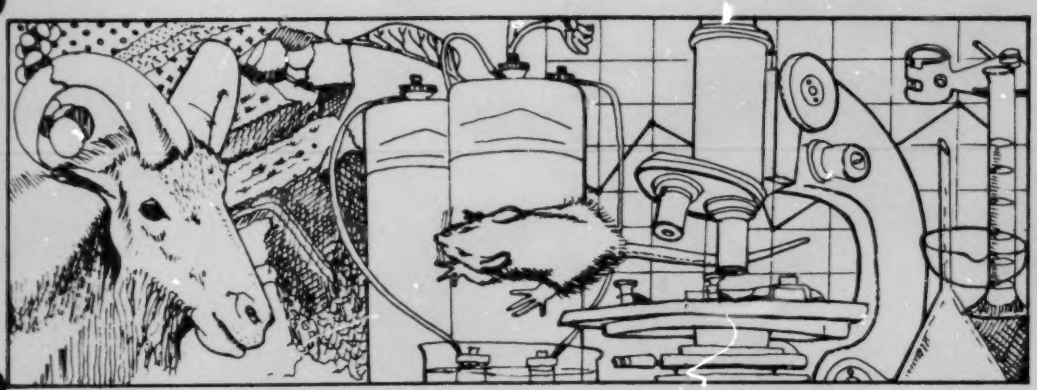
PART 2 : PRINT MASTERS FOR REPRODUCTION
(EXERCISES 1-63)



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VOLUME SEVEN OF THE SCIENCE LIBRARY OF TEST ITEMS

The Science Library of Test Items is a growing project, of which this is Volume Seven. The previous volumes and their descriptions are:

Volume One	:	a collection of multiple choice items.
Volume Two	:	a second collection of multiple choice items.
Volume Three	:	introduction and Manual to Mastery Testing.
Volume Four	:	The Practical Testing Guide.
Volume Five	:	Readability and Science Testing.
Volume Six	:	The Comprehension Testing Manual (released simultaneously with this volume.)

Forthcoming volumes include a third collection of multiple choice items, a collection of factual recall items, a further collection of comprehension items, with accompanying manual, and a revised and expanded mastery manual.

All material in the project is made available in the hope that teachers will select those parts which are of use to them in developing their own testing programmes.

ISBN 0-7240-4454-X

Comprehension Testing Programme

PART 2 : PRINT MASTERS FOR REPRODUCTION
(EXERCISES 1-63)

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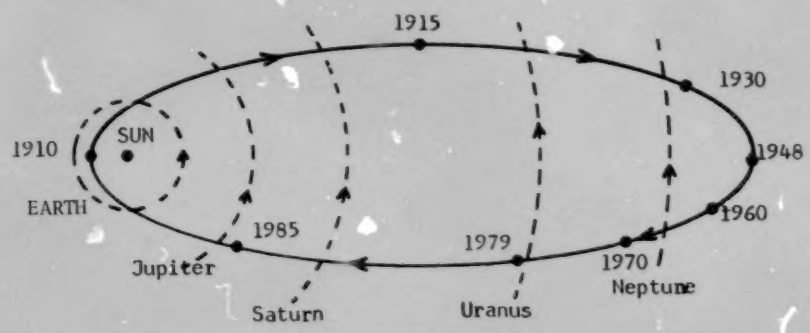
HALLEY'S COMET

The name of the most famous comet is Halley's Comet. On the average, it takes Halley's Comet 77 years to do one orbit. This length of time is called a period. The period has been as short as 74.5 years and as long as 79.3 years. The difference in time is caused by great disturbing influences on the Comet by giant planets. They are Jupiter, Saturn, Uranus and Neptune. Scientists call the disturbing influences perturbations.

Halley's Comet was last seen on its path closest to the sun in 1910. At present it is moving beyond the orbit of Neptune. In the early 1980's it should be within the orbit of Uranus and then Saturn. By 1986 the Comet should pass near the Sun again.

The ancient Chinese kept records of Halley's Comet. From these records we can trace the sighting of the Comet back to 240 B.C. So Halley's Comet has existed for at least 2000 years.

On May 20th, 1910, people could see the tail of Halley's Comet stretched across 150° - that is, nearly across the whole sky. The head (brightest part of the Comet) was then only about 22 400 000 km away from Earth. On the next day, Earth actually passed through the tail. This however, had no harmful effect.



DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do these words mean, as used in this article?

   orbit (line 3), period (line 3), perturbations (line 8), ancient (line 14), sighting (line 15), harmful (line 23)

2. What causes disturbing influences on Halley's Comet (lines 5 & 6)?

3. The Comet passed close to the Sun in 1910. Think of a person who was born that year. How old would the person be when the comet passed close to the sun again?

4. On what date did the Earth pass through the Comet's tail?

5. This article was probably written in
   a. 1910 B. 1926 C. 1962 D. 1973

6. Copy the diagram from the article. Mark clearly on your diagram the present position of the Comet.

7. Explain the expression stretched across 150° (line 12). You may use a diagram to explain your answer.

RESEARCH QUESTIONS

8. What does a comet look like?

9. What is a comet made of?

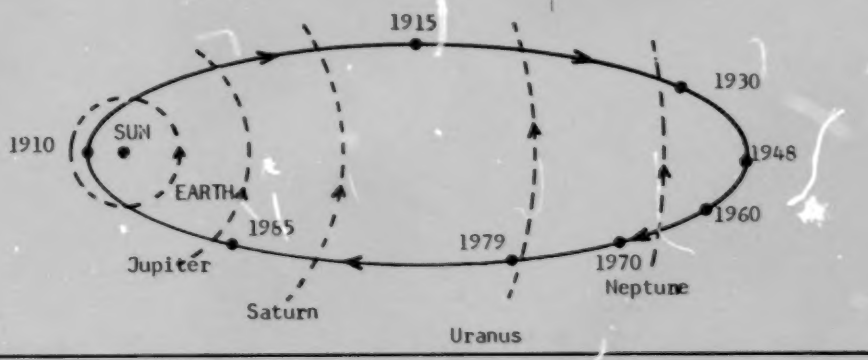
Source: H.C. King "Tackle Astronomy This Way". ★★★

HALLEY'S COMET

2a

The most famous Comet of all is Halley's Comet. This has an average period of 77 years, but the interval has been as short as 74.5 years and as long as 79.3 years. These variations are due to perturbations - to the disturbing influence of the giant planets Jupiter, Saturn, Uranus and Neptune. Its last perihelion passage was in 1910. At present it is moving beyond the orbit of Neptune, but by 1980 it should be within the orbit of Uranus, and 1986 should see the next perihelion passage. Records kept by the ancient Chinese enable us to trace its appearance right back to 240 B.C., so it has been in existence for at least 2000 years and probably much longer.

On May 20th, 1910, the tail of Halley's Comet stretched out 150^0, or nearly across the entire sky. The head, or brightest part of the comet, was then only about 22 400 000 km away and on the following day the Earth actually passed through the tail but without any untoward effects".



Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article?

   period (line 2), perturbations (line 4), perihelion passage (lines 5/6), untoward (line 16).

2. Explain the causes of the disturbing influence (line 4).

3. How long is the time between two perihelion passages mentioned in the article?

4. On what date did the Earth pass through the comet's tail?

5. This article was probably written in

   A. 1910 B. 1926 C. 1962 D. 1973

6. Copy the diagram from the article. Mark clearly on your copy the present position of the comet.

7. Explain the expression stretched out 150^0 (line 12). You may use a diagram to explain your answer.

RESEARCH QUESTIONS

8. What are some other comets?

9. Who was Halley?

10. What is a comet made of?

11. What is the shape of the orbit called?

12. Another comet, Encke's comet has a period of three and a third years. Draw on your diagram a possible orbit for Encke's comet.

SOURCE: Science Journal. ★★

FINE DETAIL OF THE SUN 3a

A new 30 cm solar telescope which will produce television-like pictures of the Sun's surface has just been completed at the observatory at Culgoora, N.S.W. The telescope will be used to photograph the fine structure of flares and other solar features. It is expected to pick up details as small as 400 km in diameter on the surface of the sun.

The main problem in observing fine details on the sun arises from turbulent currents of heated air in the Earth's atmosphere. These image spoiling currents are worse near the ground. The telescope has therefore been mounted on a 16 metre tower. It is covered by a protecting metal canopy. When the instrument is in use this can be fully retracted into the supporting structure. This replaces the conventional narrow slit dome which can itself be a source of disturbing thermal currents.

The telescope is made of open lattice work so that it stays in thermal equilibrium with the air. It is also cooled by an air suction system. The tower is unusual as it consists of two separate towers, one inside the other. The inner tower carries the telescope. The outer tower carries stairs, control room and the canopy. In this way the telescope is protected from vibrations that could blur the solar image. The towers are mounted on independent concrete foundations.

The telescope is due to go into operation in the near future.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the passage?
fine (line 4), turbulent (line 8), retracted (line 12), flares (line 4), solar (line 4), thermal (line 16).

2. What is the main problem scientists face when trying to observe small details of the sun?

3. Why were two towers used instead of one?

4. Why was the telescope made from open lattice work (line 15)? Explain how this would work.

5. What causes the disturbing thermal currents (line 14)?

6. Why is the conventional slit dome more likely to produce disturbing thermal currents than a fully retractable cover? Would the material that the cover was made of make any difference to this? Explain.

RESEARCH QUESTIONS

7. Why would the effects of the thermal currents be worse near the ground? Explain.

8. The passage mentions several allowances which have been made to stop blurring of the image by reducing vibrations in the apparatus. Others are not mentioned, but are implied in the article.

   (i) Jot as many of these down as you can find using brief, point form notes.

   (ii) List any other allowances which you would make if you were designing a telescope like this.

SOURCE: Adapted from Science Journal, June 1968. ★★★

SPACE DUST 4a

The earth, far from sailing majestically through empty space as most people think, rather resembles a vacuum cleaner in a dust storm. According to estimates it sweeps up several hundred tonnes of particles every day. Where they come from and precisely what they consist of remains an unsolved mystery.

The difficulty is, of course, to distinguish particles which have arrived from space from those of earthly origin. Putting up sticky nets and webs yields lots of dust, but where does it come from?

One technique is to screen it for radioactive particles, on the assumption that these have been made radioactive by solar energy. Unfortunately, contamination from nuclear explosions makes this a difficult process.

Another is to investigate cores of material from the sea-bed. If these contain more particles than landward cores, it is concluded that the extra particles have fallen from outer space.

Another line of investigation is an examination of polar ice. It is thought that 95 per cent of the nickel found in Antarctic ice is extraterrestrial in origin.

Observations from rockets suggest the presence of a dust cloud some 20 km above the Earth's surface. These, however, may have been misleading.

The most probable source of this material is the break-up of asteroids. It has been calculated that colliding asteroids produce as much as 100 tonnes of fragments per second. This is therefore a more likely source than comets, although some of the material may well come from the sun. Only one tonne of material would be needed to maintain the zodiacal cloud whereas up to 1 000 tonnes land on earth each day.

Although the amount is large, most of the particles reaching the Earth's surface are very small - as little as one micron in diameter. This space dust, first noticed 90 years ago, illustrates how even rather simple problems in science can resist solution until someone ingenious enough to think up effective methods of attack becomes interested in them.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is the meaning of these words as they are used in the article?
   majestically (line 1), precisely (line 4), landward (line 14), extraterrestrial (line 18), zodiacal (line 27), screen (line 9).

2. The particles referred to in the article are thought probably to originate from
   A. asteroids.
   B. comets.
   C. dust from earth.
   D. the sun.

3. What is the main problem facing researchers on this topic?

4. When was the space dust first noticed?

   A. 1868 B. 1878 C. 1880 D. 1890

5. Explain what is meant by a <u>core</u> (line 13). How it is obtained?

6. An estimated 1000 tonnes of space dust are collecting on Earth each day. Is this likely to have far reaching effects on the Earth's position in space? Explain.

RESEARCH QUESTIONS

7. How big is a <u>micron</u> (line 30)? Why do scientists use this unit?

8. Assuming the particles mentioned in the last paragraph are little cubes of side 1 micron, how many would fit into a box of volume 1 cubic metre ($1m^3$)?

SOURCE: "Science Journal"

★★

SOVIET SPACE CRAFT LANDS ON VENUS 5

The first landing of a man made object on another planet took place on March 1, 1966. *Venus 3*, one of the two Soviet probes despatched to Venus reached the surface of the planet, delivering a pennant with the coat of arms of the USSR. Two days previously, the other spacecraft, *Venus 2*, missed the planet by 24 000 km; however, it got nearer to Venus by some 9600 km than *Mariner 2* did in 1962.

Moscow said: "The precise rendezvous of the probe with the planet was achieved as a result of a mid-course correction of the flight trajectory on December 26. Throughout the flight regular radio communication was maintained with the probe and scientific information was received. During the approach of the probe to the planet the communication period at the final stage did not take place."

Nothing was mentioned in the offical report on whether *Venus 3* did anything other than crash into the planet. However, the report said that "direct and regular study of the planet Venus might soon become possible after a landing of a Soviet rocket on the planet yesterday".

The American probe, *Mariner 2*, did not carry photographic equipment but it was instrumented with radiometers, which measured the temperature at the surface at a surprisingly high 427°C and, at the top of the clouds, a very low temperature of -51°C. The unbroken cloud layer was found to be 24 km thick, ranging from an altitude of 60 km to about 75 km.

Since 1960, it has been assumed that Venus' atmosphere is composed of 96 per cent nitrogen and about four per cent carbon dioxide, with a surface pressure of more than 100 atmospheres. This extremely heavy atmosphere means that the surface of the planet cannot be anything else but smooth. The average slope is estimated to be no more than four degrees and the maximum size of any irregularity only about 10 centimetres.

The presence of such a relatively large amount of carbon dioxide and trace quantities of water vapour makes the atmosphere of Venus an extremely effective 'greenhouse'. Both are excellent absorbers of infrared radiation! In fact, only 4% of the infrared energy falling on the planet, actually escapes.

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QUESTIONS

1. What do these words mean as they are used in this article?

   probes (line 2), precise (line 7), trajectory (line 8), regular (line 9), relatively (line 29).

2. By what distance did *Mariner 2* miss Venus in 1962?

3. What is a greenhouse? Why is the atmosphere of Venus so effective as a greenhouse (line 31)?

RESEARCH QUESTIONS

4. Where does the infrared radiation (line 31) on Venus come from? Find out some facts about infrared and ultraviolet radiation. What is the importance of each to life on Earth?

5. According to the article, why is it unlikely that Venus should have mountains.

   Later space probes found that Venus does have mountains, some higher than Mt. Everest. What might have caused these mountains?

SOURCE: A. Rocca "Our Sun and its Planets" 1963, p. 34.

VENUS 6

Venus is the most brilliant of all the planets, and can even cast a shadow when at its brightest. Ancient people were familiar with it as *Hesperus*, the evening star, and *Phosphorus*, the morning star. It was Greek philosophers who first realized that *Hesperus* and *Phosphorus* are identical.

Venus moves around the sun at a mean distance of 107 500 000 kilometres. It is therefore closer to the sun than we are, and it has a revolution period or "year" of only 224.7 days. Its diameter is 12 200 kilometres, so that its size is practically the same as that of the Earth. Surely, then, it must be a world of the same general type as our own?

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. The word "brilliant" as used in line 1 means
   A. bright.
   B. striking.
   C. talented.
   D. sparkling.

2. For how many stars did ancient people mistake Venus?

3. What does the word "mean" (line 6) mean?

4. Why is the word "year" (line 8) placed in inverted commas?

5. What is a "revolution period" (lines 7 and 8)?

6. What is the approximate diameter of Earth?

RESEARCH QUESTIONS

7. (a) How many days are there in 12 Earth years?
   (b) A student is 12 years old on Earth. How many "years" old would the student be in Venusian years?

8. The surface area of a sphere is given by the formula $4\pi r^2$ where $\pi = 3.14$ and r is the radius of the sphere. Assuming Venus to be a sphere, calculate its surface area in square kilometres.

9. "Hesperus" and "Phosphorus" are derived from Greek words. Find out what they mean.

SOURCE: Adapted from "Science Journal" ★★★

INNER PLANETS ORIGINATE FROM PRIMEVAL BODIES 7

Over the years, there have been various ideas about how the planets formed. Not one of these has yet been accepted by all scientists, because most evidence is consistent with several of the explanations. Also, each model has weaknesses which have yet to be resolved.

A clue which may help eventually to solve this puzzle has come from measurements of the masses of the inner planets and the radii and shapes of their orbits. These measurements show a pattern in the way mass is distributed amongst the inner planets.

When the masses are plotted against the densities of the planets a graph with apparently random scattering of points is produced. This fact points to large differences in the chemical compositions of the planets.

However, the latest figures show that if Mercury and Venus were combined into one body and the Earth, its moon, and Mars into a second body, the two would have almost identical densities and comparable masses. This is just what we would expect if the planets formed from a single cloud of gas and dust.

It can be shown that such combined planets would be unstable due to the wide range of densities of the elements in them, plus their high rate of rotation. They would break up early in their formation, giving a distribution of matter like that found in the present inner planets.

Thus the mass distribution of the inner planets is consistent with their being formed from a single collapsing gas cloud. The distribution is *not* consistent with another major theory which suggests that the planets grew from the build-up of separate small particles into aggregations of matter.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as used in this article?

   primeval (in title), model (line 4), densities (line 9), random (line 10), comparable (line 14), unstable (line 17), aggregations (line 24).

2. What are the names of the "inner planets" mentioned in the article?

3. a) What is meant by "chemical composition" (line 11)?
   b) What fact leads scientists to believe that the chemical composition of the planets is not the same?

4. The article states that the inner planets originated from *primeval bodies*. How many primeval bodies?

5. Which heavenly body mentioned in the article is not strictly a planet? Why?

RESEARCH QUESTIONS

6. Using data from an astronomy book, plot a graph like the one described in the article (paragraph 3) for *all* the planets in the solar system. Are the points for the inner planets scattered as claimed in the article? Are the points for the outer planets different to those of the inner planets?

7. Why does the article refer to the *masses* of the planets and NOT their *weights*?

8. How do scientists measure the masses and orbital radii of the planets? Are the methods used today the same as, or different to, those first used in the past?

ATMOSPHERIC RE-ENTRY 8

If people are to travel to the planets they must use space ships which travel quickly. If they don't, the journey will take many years. One problem of high speeds is atmospheric re-entry to Earth. At great speeds, rapid heat build up and deceleration will cause difficulties.

It is, however, fortunate that the Earth has an atmosphere. Without it planes could not fly. Without it, birds could not leave the ground. Parachutes would be useless. Even the smallest meteors would bombard the Earth's surface. Basically the atmosphere covers the Earth with a medium which resists motion. This resistance can be used to slow down space vehicles.

The two main problems still exist. Firstly, air resistance dissipates the energy of motion of the craft as heat. This heat can result in ablation of the craft by melting, burning, boiling or sublimation. Nearly all meteors are destroyed this way. The second problem is caused by the structure of the atmosphere. It is much denser near the Earth's surface. In fact, 99% of the mass of the atmosphere is in the bottom 32 km. Vertical re-entry would be like driving a car into a brick wall. Under these conditions, a pilot would experience forces of 180g.

In order to reduce these problems, space-craft don't re-enter vertically. Instead, they "graze" the atmosphere. They re-enter at a shallow angle. This reduces the deceleration to 15g. This is the maximum the human body can stand for more than a few seconds without damage. The craft "skips" in and out of the atmosphere. It slows down gradually and a lot of the heat of re-entry dissipates into space before the final plunge into the atmosphere occurs.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as they are used in this article? medium (line 9), resists (line 9), dissipates (line 12), ablation (line 13), denser (line 15), verticle re-entry (line 17).
2. What problems are caused by the atmosphere for the re-entry of spacecraft?
3. What is done to reduce these problems?
4. What benefits of the Earth's atmosphere are mentioned in the article?
5. Draw a diagram showing the Earth and its atmosphere. Show a spacecraft and the path a spacecraft takes on re-entering the atmosphere.

RESEARCH QUESTIONS

6. How far does the atmosphere extend into space? Draw a diagram which shows the various characteristics of the atmosphere. Give as many details as you can.
7. What is meant by 180g (line 19)? What effects do high accelerations have on the human body? How do scientists conduct experiments to observe and measure these effects?

SOURCE: Charles Darwin "The Voyage of the *Beagle*". ★★★

PASSAGE OF THE CORDILLERA 9a

The rivers which flow in these valleys ought rather to be called mountain torrents. Their inclination is very great, and their water the colour of mud. The roar which the Maypu made, as it rushed over the great rounded fragments was like that of the sea. Amidst the din of rushing waters, the noise from the stones, as they rattled one over another, was most distinctly audible even from a distance. This rattling noise, night and day, may be heard along the whole course of the torrent. The sound spoke eloquently to the geologist; the thousands and thousands of stones, which, striking against each other, made the one dull uniform sound, were all hurrying in one direction. It was like thinking on time, where the minute that now glides past is irrecoverable. So was it with these stones; the ocean is their eternity, and each note of that wild music told of one more step towards their destiny.

It is not possible for the mind to comprehend, except by a slow process, any effect which is produced by a cause repeated so often, that the multiplier itself conveys an idea, not more definite than the savage implies when he points to the hairs of his head. As often I have seen beds of mud, sand, and shingle, accumulated to the thickness of many thousand feet, I have felt inclined to exclaim that causes, such as the present rivers and the present beaches, could never have ground down and produced such masses. But, on the other hand, when listening to the rattling noise of these torrents, and calling to mind that whole races of animals have passed away from the face of the earth, and that during this whole period, night and day, these stones have gone rattling onwards in their course, I have thought to myself, can any mountains, any continent, withstand such waste?

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? torrents (line 2), inclination (line 2), audible (line 6), uniform (line 10), irrecoverable (line 12), accumulated (line 19).

2. What is the significance to geologists of the fact that the rivers had water the colour of mud (line 3)?

3. The Maypu referred to in line 3 is most probably a
   A. bird.
   B. lion.
   C. river.
   D. sea.

4. What does Darwin mean when he says that the sound spoke eloquently to the geologist (line 8)?

5. Darwin says of the stones that the ocean is their eternity (lines 12 and 13). What does he mean by this? According to modern knowledge, is he right?

6. What does Darwin mean when he says <u>can any mountain, any continent, withstand such waste?</u> (lines 26 and 27)

RESEARCH QUESTIONS

7. Who was the first person to use the term "geologist or "geology"?

8. Find out what "uniformitarianism" was (it is a theory of geology). Did Darwin support this theory or not? Why?

9. The views of James Usher (also spelt Ussher) had an effect on Darwin's thinking, but Darwin finally rejected Usher's ideas. Find out what Usher's views were. Are they accepted today?

SOURCE: Adapted from Science Journal July 1966. ★★★★

LARGE CRACK FOUND UNDER PACIFIC OCEAN

10a

An enormous shift in the Earth's crust, equivalent to moving Sydney nearly 300 kilometres has been discovered in the Pacific Ocean. However, whether it resulted from an incredible displacement that took place in a short time, or was caused by small shifts occurring during millions of years is not known.

The crack was discovered by the U.S. Coast and Geodetic Survey ship *Pioneer* while it was studying the area between the Hawaiian and Aleutian Islands. It was found that the variations in the Earth's magnetic field, shown by a 1965 survey, fitted neatly into a pattern that had been partly established by previous ocean sounding. This was equivalent to finding "the key piece of a jigsaw puzzle" said Dr. Harris Stewart, director of the project.

The survey being carried out by *Pioneer* was aimed primarily at collecting basic ocean data for such practical applications as charting currents - information essential to the fishing industry and weather prediction.

The magnetic field is measured by a magnetometer trailed behind the ship. When the magnetic field has been mapped systematically over a large area, the information can be fitted together to make a contour map of the ocean bed. This can be done because some rocks are more magnetic than others, and they retain their magnetism no matter how far they move.

Scientists on *Pioneer* detected a pattern showing that a band of rock some 8 km wide with uniform magnetic characteristics was once aligned in a diagonal that stretched at least 2500 km. This band of rock has since moved at least 300 km, and, as some evidence suggests, possibly as far as 1000 km.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? displacement (line 3), variations (line 8), basic (line 14), charting (line 14), systematically (line 17), characteristics (line 22).

2. What was the purpose of the survey carried out by *Pioneer*?
   A. To map the Earth's magnetic field.
   B. To check a 1965 survey.
   C. To collect information about the ocean bed.
   D. To make a contour map of the ocean bed.

3. The magnetic field information can be used to map the ocean bed because
   A. variations exist in the Earth's magnetic field.
   B. some rocks are more magnetic than others.
   C. the information fits neatly into a pattern.
   D. rocks remain magnetic for a long time.

4. The resulting contour map (line 18) would show
   A. height of the ocean bed above ocean bottom.
   B. depth of the ocean floor below sea level.
   C. magnetic field patterns on the ocean bed.
   D. types of ocean currents near the ocean floor.

5. The displacement referred to in the article (line 3) is most probably a
   A. fault.
   B. fold.
   C. joint.
   D. geosyncline.

6. What did Dr. Stewart mean when he said "the key piece of a jigsaw puzzle"?

RESEARCH QUESTIONS

7. Explain, with the aid of a diagram, just how the magnetic field variation headings could give evidence for the rock displacement described in the article.

8. Explain how this type of movement can occur in the earth's crust. Use diagrams, if possible, to illustrate your answer.

9. Imagine your school has been displaced 300 km to the west. To what *present* town would your school be nearest?

SOURCE: F.T. Barrell "Modern Science" p. 57. ★★

THE CORE OF THE EARTH 11

The core of the Earth extends from 2 900 kilometres below the surface into the centre of the Earth which has a radius of 6 400 kilometres. Earthquake studies show that the core itself consists of a solid inner zone about 1 300 kilometres in radius and an outer liquid zone. Physicists set the Earth's average density at 5.5 and geologists find the Earth's exterior surface material to have an average density of about 3; calculations show that the core must have a density of about 15 to bring the overall average to 5.5. Hence it is deduced that the core must consist mostly of iron with a little nickel and some cobalt.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is the meaning of the following words as used in the article?
   density (line 5) and deduced (line 8).

2. Physicists and geologists are both scientists. How does the work they do differ?

3. What kinds of substances are iron, nickel and cobalt?

4. What is the radius of the core?

5. How many layers do scientists believe that the core is made up of? What distinguishes these layers?

6. What is the thickness of the outer liquid zone?

7. Is the deduction given in lines 8 and 9 a valid one?

RESEARCH QUESTIONS

8. Using a reference book draw a cross-section of the Earth and label the main zones of the Earth's interior.

9. What are some of the characteristics of each of these zones?

10. What evidence do scientists have for believing that the core of the Earth contains iron, nickel and cobalt?

SOURCE: "Everything has a history", J. B. S. Haldane, Allen and Unwin, 1951.

★

THE EARTH SPINS. 12

We are taught in school that the earth goes round the sun, that the light from the nearest star takes several years to get here, and so on. We ought not to take such statements on authority. We ought to know something of the evidence on which they are based, and even to check it if we have the opportunity. Otherwise we shall get into the habit of believing anything that we hear often enough...

...The first piece of new evidence for the theory (that the earth is round) arose when it was shown that pendulum clocks went slow in the tropics...This is at once explained, if the earth's spin makes its equator bulge out. The combination of centrifugal force and greater distance from the centre lessens the force of gravity, and slows down a clock regulated by a pendulum, but not one regulated by a hairspring...

...Probably the most dramatic of all the proofs of the earth's rotation was the experiment which Foucault did a hundred years ago with a very long pendulum suspended from the dome of the Pantheon in Paris. The pendulum, which was merely a weight on the end of a rope, was set swinging and left. Common sense suggests that the pendulum will keep swinging in the same plane, or at least in a series of parallel planes. Physical theory supports common sense. The question is whether "the same plane" is fixed relative to the earth or relative to the fixed stars. When the experiment is done, the plane of swing moves relative to the building, but keeps as steady as it can relative to the stars...All it needs is a large building with no serious air draughts, so that the pendulum can go on swinging for some hours.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean, as used in the article?
   evidence (line 4), centrifugal (line 13), regulated (line 14), pendulum (line 15), dramatic (line 16), plane (line 22).
2. The dots (....) and the words in brackets on lines 9 & 10 (that the earth is round) indicate something about this passage. What do those two things tell you about this passage?
3. What is meant by the expression relative to the earth (line 24)?
4. Why does Haldane say that physical theory supports common sense (line 22 & 23) in the view that the pendulum will continue to swing in the same plane?
5. If the pendulum appears to turn, does this mean that physical theory and common sense are wrong?

RESEARCH QUESTIONS

6. Why are hairspring clocks not affected at the equator?
7. What was the first Pantheon? What is the Pantheon in Paris? Does the word still mean the same thing?
8. What are fixed stars (line 25)? Are there any "unfixed? stars?
9. Would a Foucault pendulum work at the North Pole? At the equator?

Source: Adapted from Science Journal, July 1966. ★★★

13a

ARE THERE HIGH MOUNTAINS ON MARS?

Regions on the surface of Mars may vary in height by about five kilometres. Measurements made by the *Mariner IV* fly-by on June 15, 1965, indicate tentatively that the Electris area of Mars' southern hemisphere is about 5000 metres higher than the Mare Acidalium in the northern hemisphere.

During the 54 minute passage behind Mars at a distance of about 26 000km, *Mariner IV* recorded measurements which indicated that the first surface feature mapped during the occultation period was 3384km from the planet's centre. The radius at the point where *Mariner* emerged from behind Mars was found to be 3379km. Moreover, the surface atmospheric pressure in the exit area was higher (7 to 10 millibars) than at the point where *Mariner* first was eclipsed by the planet (4 to 7 millibars).

Although these results cannot be taken as conclusive, assertions have been made that "the cause of the observed difference in atmospheric pressure most probably is altitude difference".

The manner in which pressure varied with height appears to verify earlier reports that the Martian atmosphere is composed mainly of carbon dioxide with some argon and nitrogen. Thinness of the Martian atmosphere is attested by the pressure ranges of 4 to 10 millibars. On earth, 10 millibars would correspond to the pressure at an altitude of about 30km.

Temperature measurements at the entry and exit points of the fly-by indicate surface temperatures of about -98^0C and -37^0C respectively. The probe also indicated the presence of an ionosphere with a maximum density at a height of about 124km compared with 250 km for the maximum in Earth's ionosphere.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article?

   tentatively (line 3), occultation (line 8), eclipsed (line 13), assertions (line 15), attested (line 21).

2. How far above the surface of Mars was the orbit of *Mariner IV*?

   A. 3384km B. 5000km C. 26 000km D. 250km

3. What is the most common gas in the Martian atmosphere?

4. The surface atmospheric pressure on Mars appears to be between

   A. 4 - 7 millibars.
   B. 7 - 10 millibars.
   C. 4 - 10 millibars.
   D. 37 and 98 millibars.

5. Why were the measurements <u>recorded</u> (line 7) rather than broadcast direct?

6. Give a value for the approximate diameter of Mars.

7. Why can't the observations made by *Mariner IV* be taken as <u>conclusive</u> (line 14)?

RESEARCH QUESTIONS

8. Which directions best describe the passage of *Mariner IV* behind Mars?

A. East to West.
B. North to South.
C. South to North.
D. West to East.

9.(a) "Mare" is a Latin word. What does it mean?
(b) Is it an appropriate name to use on Mars?

10. The information in the passage could be interpreted as indicating some seasonal differences on the different areas of the surface. Explain.

11. Calculate an *approximate* speed for *Mariner IV* during its fly-by of Mars.

★★★

14a

THE MOONS OF MARS

Exploration of Mars will surely include an investigation of its extraordinary satellites. There are two of them, Deimos and Phobos, and their small size and proximity to the planet make them unique in the solar system. Deimos is about five kilometres in diameter and about 24 000 kilometres from the surface of Mars. The satellite Phobos, eight kilometres in diameter, is much closer (9300 kilometres).

The most remarkable thing about Phobos, according to some observations, is that its period of revolution appears to be decreasing slowly but perceptibly. The only plausible explanation is that the slight drag of the Martian atmosphere is taking energy from it, thus making it move closer to Mars and follow a shorter and faster orbit. The Martian atmosphere is so thin that a satellite affected in this way must have extremely low density. If the observations are correct (which is not established), Phobos must be lighter than any known solid substance, even lighter than any natural porous material that could hold together.

The Russian astronomer Iosif S. Shklovsky has supplied the world with a novel answer to this puzzle. Professor Shklovsky maintains that Phobos is both hollow and artificial, the ingenious creation of a group of highly civilized Martians of hundreds of millions of years ago. When they realized that their civilization would soon become extinct, his reasoning continues, they constructed one or two extra-ordinarily spacious satellites to serve as libraries and museums, and preserve for future space explorers and historians a permanent record of the history and achievements of their doomed civilization.

Intriguing as it sounds, Shklovsky's idea is definitely a minority view. Few scientists count on finding any such convenient repositories of ancient learning, and the possibility of discovering any sort of intelligent, civilized life still flourishing on Mars is considered extremely unlikely. Nevertheless, the future explorers of Mars will look carefully for any archaeological evidence of long-dead civilizations.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these terms mean, as they are used in the article? satellites (line 2), period of revolution (line 8), plausible (line 9), density (line 12), porous (line 14), archaeological (line 28).

2. What are the names of the two moons of Mars?

3. Why are these moons called satellites (line 2)?

4. What makes the two moons of Mars unique in the solar system (line 3)?

5. What appears to be happening to Phobos, according to some observations?

6. What is the reason for this "happening"?

7. Shklovsky's "answer" (see paragraph 3) is best described as

   A. a scientific law.
   B. a theory.
   C. a fact.
   D. a principle.

8. Suggest reasons why Shklovsky's idea is a minority view (line 24).

RESEARCH QUESTIONS

9. Deimos and Phobos come from two Greek words. Find out what they mean.

10. Why must Phobos be lighter than any known solid substance (lines 13 and 14)? What scientific principles are involved?

★★

French discover tenth satellite of Saturn

15

A tenth moon of Saturn has been discovered by a French astronomer Dr Audouin Dollfus. The satellite was first detected when the planet's rings were seen edge on from Earth. The new finding was confirmed by R.L. Walker of theUS Naval Observatory's Flagstaff Station. When he heard of Dollfus' discovery, he took 24 photographs several nights later. In four of these, the new satellite was visible.

The satellite lies close to the outer edge of Saturn's rings, approximately 158 000 kilometres from the planet. Its brightness is magnitude 14, too faint to be seen except through large telescopes. The tenth satellite circles Saturn once every 18 hours.

The principal difficulty in observing Saturn's moons is caused by the famous ring system which surrounds the planet. These rings, recently estimated to be about 25 cm thick, consist mostly of small rock fragments, stretching from about 72 000 kilometres to 138 000 kilometres from Saturn's centre. They exert a light scattering effect which makes the detection of any small object lying close to the planet, extremely difficult. However, about three times a year the rings of Saturn are seen edge on from Earth, making observation much easier.

One such period was on June 15, 1966. Photographs taken then did not show a new satellite but made it clear that the luminosity surrounding Saturn, was still a serious problem. In order to reduce this effect still further, Dollfus fitted to his telescope a band of tinted gelatine which exactly covered the disc of the planet and also just obscured the rings. This reduced the scattering of stray light to about one per cent.

When the Earth again passed through the plane of Saturn's rings, conditions for observation were ideal. Photographs taken in December showed a small bright point of light inside Saturn's halo. Subsequent calculations of the orbit proved it to be a new satellite.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do these words mean as used in the passage?
   satellite (line 6), principal (line 11), estimated (line 13), luminosity (line 20), visible (line 6).
2. What is the main difficulty in observing Saturn's moons?
3. Before Dollfus could successfully observe the tenth satellite, certain conditions had to be met. *Explain* these conditions.
4. What is the orbital period of the tenth satellite?
   What is the width of Saturn's rings?
   What is the approximate diameter of the orbit of the satellite?
5. What property of light is causing the light scattering effect? Explain how this comes about.
6. Why is it necessary for a discovery such as this to be confirmed (line 3), as this was by R.L. Walker. Does this confirmation apply to all scientific discoveries?

RESEARCH QUESTIONS

7. Make a list of the satellites of Saturn (13 are known now, and two more suspected), giving their names and sizes and any other information about them that interests you.
8. What is meant by magnitude 14 (line 9). Find out how the brightness of stars and planets is measured.

★★

LEECHES PUT INTO ORBIT

16

It is planned to send four leeches into orbit for more than a year. The aim is to get information about how the metabolism of living creatures, including humans, might be affected by long periods in space. Previous experiments with animals in space have been much shorter. This is mainly because considerable supplies of energy have to be available in the satellite to cope with their feeding and to dispose of their waste products. Leeches do not pose these problems. Once they have been fully fed they need nothing more, except minute quantities of oxygen for up to 1½ years. Further, they process their food so well that very little is excreted. The main waste product is carbon dioxide which is easily dealt with.

The plan is to feed the leeches and then have them in a small water-filled cylindrical compartment. The water will be kept circulating with a small pump. As the water circulates it will be constantly enriched with oxygen - the leeches require about 5mm^3 an hour. The carbon dioxide and other excreta will be filtered out. The whole unit weighs about 3kg and requires a power of only about 5 watts for lighting, operating the pump, conducting electrical measurements and relaying the data to Earth.

It is hoped that scientists will learn about metabolism and behaviour changes caused by the long period of weightlessness and also by the altered rhythm of day and night. Even though leeches have no skeletons, it may also be possible to study the probable loss of calcium from human bones in extended space travel by studying certain changes in the organs of the leeches. Finally, the scientists may allow reproduction to take place. They could then study possible harmful genetic effects humans might suffer due to lengthy exposure to outer space radiation. Mature leeches produce up to 14 cocoons in three months.

At present, the leeches are being extensively observed for a year in the laboratory. In this way all necessary comparative data for possible changes will be available.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as they are used in this article?

   metabolism (line 2), minute (line 8), process (line 9), cylindrical (line 12), enriched (line 13), excreta (line 15), conducting (line 17), behaviour (line 18), rhythm (line 20), cocoons (line 26), comparative line 28)

2. Why are the leeches being sent into space?

3. What are the advantages of sending leeches into space? Why are leeches preferred over other animals such as mice or monkeys which are more like man?

4. Leeches have no skeleton. How can they give information about bones?

RESEARCH QUESTIONS

5. (a) If the leeches were sent into orbit for 1 year, how many cubic millimetres of oxygen would they need for the year?
   (b) How many litres does this represent?

6. Find out why leeches can survive for up to 1½ years after being fully fed (line 7)

7. What could be the cause of harmful genetic effects (line 24)? Can you think of any evidence which might cause scientists to expect harmful effects?

8. Find out more about the life cycle and habits of leeches. What is their role in the *web of life*?

SOURCE: Science Journal, May 1967 ★★★

IS LIFE EVOLVING ON JUPITER? 17a

According to Dr. Robert Jastrow, an American astrophysicist, life may be evolving on the planet Jupiter. Some tentative evidence points to a chemical evolution towards life. This is comparable with the process thought to occur on the primitive Earth 3500 million years ago.

Jupiter's atmosphere is now known to be rich in the basic chemical 'building blocks' of living matter. These are carbon, hydrogen, nitrogen and oxygen. These could produce an atmosphere of methane gas or hydrocyanic acid. Substances like this formed the primordial 'soup' that became the matrix of primitive life forms on the early earth. Water, another essential ingredient, is also present.

These substances have been detected in Jupiter's atmosphere by examining reflected light from the planet.

"The forms of life that could develop there we can't guess", says Jastrow. "It would take a five year round trip by a manned spaceship to find out. This is many years away."

Jastrow favours the rise of very different forms of life on Jupiter. This is because the conditions are so different, particularly the high pressure and extreme heat. These eliminate the possibility of earth type life.

Jupiter is known to bake in 'primitive gravitational heat'. Its surface radiates four times the energy which it receives from solar radiation. Jupiter's heat and size - it is one tenth the diameter of the sun - make it almost a star. Jupiter alone contains more matter than all the other planets together.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the passage? astrophysicist (line 1), tentative (line 2), basic (line 6), primordial(line 9), matrix (line 10), conditions (line 18), radiates (line 22), matter (line 25).

2. What are the main elements in Jupiter's atmosphere?

3. Why are life forms that could develop on Jupiter likely to be different from those on Earth?

4. Why does the author use the term 'building blocks' (line 7) to describe the substances in Jupiter's atmosphere?

RESEARCH QUESTIONS

5. Use your library to find out about the chemosynthetic origin of life. Who first proposed this theory and how does it stand today?

6. Find out what two scientists, Urey and Miller, have to do with this theory on the beginnings of life on Earth.

7. Water is said to be an essential ingredient for life (line 11). Make a list of the reasons water is essential to life.

8. Use the library to find out what physical and chemical properties water has which make it such an essential ingredient for life. Explain the relevance of each.

9. What is meant by the term primitive gravitational heat (line 21)?

10. Construct a table to show the masses of the planets. Calculate how much (%) of the total mass is due to Jupiter.

SOURCE: Science Journal May 1966. ★

FOG BROOMS

18a

A fog broom has been designed in New Jersey by State Highway Department engineers. The broom will clear a pathway on fogbound roads. The device consists of four wooden frames which spin rapidly. Each frame is strung with closely spaced vertical nylon threads. The frames are mounted much like the vanes on a wind indicator. As the frames rotate fog droplets collect on the nylon threads. The drops run down the threads and collect in a container at the base of the frame. Initial tests in a fog chamber have been very successful. However, more tests have to be made, particularly full scale tests involving several fog brooms on a truck. The truck would drive down a fog bound highway to see if a significant difference was made.

To test the fog broom idea, frames were made 120 cm high and 65 cm wide. The broom was rotated at 75 rpm for 13 minutes, in a room fogged to saturation point. The room, with a volume of 50 cubic metres, was clear of fog in six minutes.

Engineers in Chile use similar devices to convert mountain fogs into water for irrigation purposes. The Chileans use stationary frames as the mountain breezes blow the fog through the nylon strands.

Two theories have been proposed to explain why the fog broom works. The first suggests that friction between the nylon and the air produces an electrostatic charge. This charge attracts water molecules suspended in the foggy atmosphere. The second suggestion is that water molecules are physically bound together as they pass between the threads. This causes them to collect together to form water droplets.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do the following words mean, as used in the article? fogbound (line 2), vanes (line 5), significant (line 12), proposed (line 21), electrostatic (line 23), suspended (line 24), physically (line 25).

2. What do fog droplets (line 6) consist of?

3. The physical change which occurs in this process is
   A. condensation.
   B. evaporation.
   C. solution.
   D. saturation.

4. What is a full scale test (line 10)?

5. (a) Why is this device called a 'fog broom'?
   (b) How does it work?

6. Why are the explanations of how the fog broom works (see last paragraph) referred to as 'theories'?

7. Draw a simple sketch of the device described in the passage. Label your diagram.

RESEARCH QUESTIONS

8. Which property of water would result in its molecules being attracted to statically charged nylon threads?

   A. It has a relatively high boiling point.
   B. It has a polar molecule.
   C. Its surface tension is relatively high.
   D. It can exist in vapour form.

9. An electrostatic device is used to remove fine solid particles from the atmosphere in factories. Look up the Cottrell Precipitator in the library and describe its construction and use.

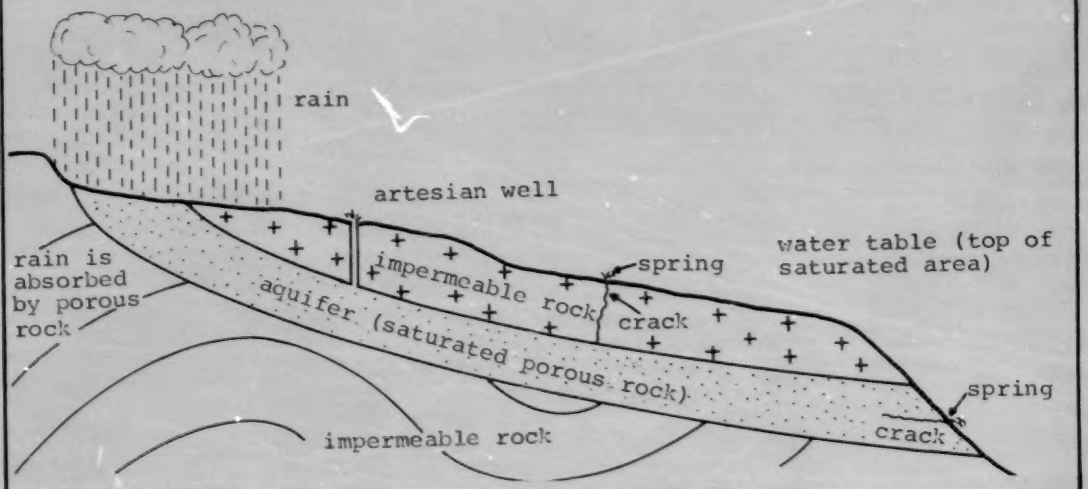
UNDERGROUND WATER

Water on or under the ground will only flow if there is a downward slope or gradient. How fast underground water flows depends on:
(i) the gradient of the rock layers.
(ii) how much water different rocks will absorb.

Rocks which absorb water are called impermeable or impervious. When a porous rock has all its open spaces filled with water, it is said to be saturated. A saturated rock is called an aquifer. The top of this saturated zone is called the water table. To be an aquifer, the porous rock has to be:
(i) exposed to the atmosphere at one end.
(ii) sloping down from its exposed end.
(iii) sandwiched between two layers of impermeable rock.

If a hole is drilled throught the impermeable rock, the underground water can come out to the surface. This water is called artesian water. The hole is called an artesian well.

If water comes out naturally from the ground, this is called a spring. A spring can form in any open spaces or cracks between the water table and the surface.



DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do these words mean, as they are used in the article?
gradient (line 2), impermeable (line 5), impervious (line 5), saturated (line 7), aquifer (line 8), naturally (line 16).

2. Why does an aquifer have to be
a) exposed to the atmosphere at one end (line 10)
b) sandwiched between two layers of impermeable rock (line 12)

3. What is the difference between artesian water and a spring.

4. If you spilt a bag of salt into a well, the water does not stay salty for very long. Why would this be so?

5. In a spring water comes out naturally (line 16). What does this mean?
A. It comes out through tree-root holes.
B. It is full of living things.
C. It is good for people to drink.
D. It comes out with no help from people.

6. Draw a diagram to show what is meant by sandwiched (line 12).

GROUND WATER

Water flows in streams and rivers because there is a gradient. This gradient is determined by the slope of their beds. Ground water also flows because its bed has a gradient. In this case the gradient roughly matches the slope of the surface. The speed of flow depends on the gradient and the permeability of the rock.

Any hole below the water table will fill with water and form a well. The rate of water flow into a well depends on the amount of ground water available at that particular place. An artesian well obtains water from a porous rock layer exposed at one end and sandwiched between an upper and lower layer of solid rock. The porous layer, called an aquifer, slants downward from its exposed surface.

A spring is found where ground water comes naturally to the surface. There are many types of springs: any exposed surface between the water table and the ground may result in the formation of a spring. Hillsides are common locations for springs because a slope on the surface often drops below the level of the water table. Such springs usually do not flow continuously, since the water table may drop below the slope in dry periods. However, one type of hillside spring is likely to flow continuously. This is a spring formed at the zone of contact between permeable and impermeable rocks. Water filters down through the permeable rock and comes to the surface on a hillside when it meets the impermeable rock layer.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? gradient (line 1), permeability (line 5), artesian (line 8), porous (line 9), aquifer (line 10), spring (line 12), impermeable (line 20).

2. Why does the artesian aquifer need to be exposed at one end (line 9)?

3. Why does an aquifer need to be sandwiched between an upper and lower layer of solid rock (lines 9 and 10)?

RESEARCH QUESTIONS

4. What is the difference between an artesian well and a sub-artesian well?

5. Aquifer (line 10) comes from two Latin words. What are these words and what do they mean?

6. Draw a diagram to show the two types of spring described in the third paragraph.

7. If you spill a bag of salt into a well, the water does not stay salty for very long. Why would this be so?

SOURCE: From "Scifile" March 1979, ★★★

21a

SALINITY

Of more than 160 million hectares of the world's arable land under irrigation, one third is estimated to be plagued with salinity problems. In Australia, salinity causes an estimated $20 million loss of yield of horticultural crops a year in the Mallee zone of South Australia alone.

Salt levels in the Murray River in Sunraysia (N.S.W./Vic.) now border on the maximum level set by the World Health Organisation as acceptable for drinking water. Irrigation with water of this quality would, over a growing season, deposit over five tonnes of salt on each hectare of irrigated land.

Salinity in Australia can pose a greater risk to certain agricultural crops such as trees, vines and other woody species than comparable levels of salinity in many regions overseas. This is because the total dissolved salts in most Australian waters consist largely of chlorides rather than the sulfates or mixtures of the two that occur in many other parts of the world.

The most obvious manifestation of salinity in the field is leaf burn, but the effects of salt are usually more subtle, resulting in growth depression without attendant leaf burn symptoms.

Recent experiments ... have demonstrated a progressive loss in the ability of grape vine leaves to photosynthesize as the level of chloride accumulated within the leaves increases. This aspect of salt toxicity often goes unrecognized because the plants seem healthy in appearance.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is the meaning of the following words as used in the passage:
arable (line 1), irrigation (line 2), salinity (line 2), horticultural (line 4), agricultural (line 11), photosynthesize (line 21), toxicity (line 23).

2. What area of the world's arable land, approximately is affected by salinity problems?

3. (a) How much salt is being deposited on each hectare of irrigated land in each growing season in the Sunraysia district?
(b) From where does this salt come?

4. Why are salinity problems in Australia a greater hazard to crops than comparable salt levels overseas?

5. What are some of the symptoms of plant life caused by too much salt in the soil?

6. (a) What causes plants to become less efficient to photosynthesis?
   (b) Why does this problem <u>often go(es) unrecognised</u> (line 23)?

RESEARCH QUESTIONS

7. Find out why Australian waters consist largely of dissolved chlorides.

SOURCE: Adapted from Science Journal, October, 1966. ★★★★

22a

CHEAP WATER FOR ARID ZONES

A simple method of purifying artesian bore waters has been developed by a geologist at the University of Melbourne. The new method, although only tested on a small scale is hailed as having economic importance for the watering of domestic stock in parched areas of the world. For instance it has been estimated that one third of the sheep in the extensive semi-arid areas are within reach of bore waters, which are at present unusable because they contain toxic quantities of magnesium salts.

The method simply involves passing the contaminated water through a bed of lime and coarse sawdust. The calcium in the lime exchanges with the magnesium in the bore water forming the less soluble magnesium hydroxide which precipitates out. The sawdust keeps the mixture porous and prevents clogging by the precipitate. The calcium, which goes into solution in place of the magnesium, gives rise to no ill effects in animals. Indeed, it may even be beneficial in providing much needed calcium for the diet of most stock.

To the general benefit of the animals is a reduction in the total quantity of salts in the water. Some of the calcium going into solution from the lime is precipitated as calcium sulfate. The sulfate being the ion originally accompanying the magnesium in the bore water.

The effect of magnesium on the physiology of sheep and cattle is much the same as that of Epsom salts on the human system. Diarrhoea is a frequent symptom and the researchers feel that this major cause of nutritional disturbance in sheep and cattle will lessen considerably as a result of the new purifying method.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do the following words mean, as they are used in the article? hailed (line 3), parched (line 4), estimated (line 5), semi-arid (line 5), toxic (line 7), contaminated (line 8), porous (line 11), precipitate (line 12).

2. Some bore waters are unsuitable for livestock because they contain toxic amounts of
   A. calcium hydroxide.
   B. lime.
   C. magnesium hydroxide.
   D. magnesium sulfate.

3. Which substance tends to clog the bed of lime and coarse sawdust?
   A. Calcium hydroxide.
   B. Calcium sulfate.
   C. Magnesium hydroxide.
   D. Magnesium sulfate.

4. Which two substances are least soluble?
   A. Calcium hydroxide and magnesium hydroxide.
   B. Calcium sulfate and magnesium sulfate.
   C. Magnesium hydroxide and calcium sulfate.
   D. Magnesium sulfate and calcium hydroxide.

5. The purifying process most resembles
   A. filtration followed by evaporation.
   B. precipitation followed by filtration.
   C. neutralization followed by precipitation.
   D. neutralization followed by filtration.

RESEARCH QUESTIONS

6. How would such large quantities of mineral salts get into the bore water? Why would the quantity be greater than in other ground waters?

7. The main element making up the dissolved salts in the bore water is magnesium. Suggest a reason for this.

8. (a) What is (are) Epsom salts?
   (b) How many are there?
   (c) What is the correct chemical name of Epsom salts?
   (d) What is the origin of the name "Epsom salts"?
   (e) What effect does a dose of Epsom salts have on the human digestive system?

9. (a) What is diarrhoea?
   (b) Diarrhoea occurs when the digestive system does not function properly. What does it fail to do? (Hint - what is the function of the large intestine?)

MINERAL LAKES

Some lakes in Sweden have too much mineral salt dissolved in them. In particular the waters contain too much phosphate. The large amount of mineral material causes rapid growth of algae. The lakes act as big fertilised bowls. The algae are 'blooming'. The problem is worse during the warm summer when visibility in the water drops to as little as 700 mm.

The problem is increased by sewage which flows into the lake. A solution to the problem has been suggested by scientists at the Water Pollution Research Institute. They intend to spread tonnes of aluminium sulfate over the surface of the lake.

They predict that the phosphate in the water will react with the aluminium sulfate to form aluminium phosphate. This is insoluble and will precipitate out to the bottom of the lake. It will then simply become part of the sediment on the bed of the lake.

In this way they hope to reduce the level of phosphate in the water. At the same time visibility should increase. Conditions will become more suitable for other lake creatures. They hope to lower the phosphate level from 60mg/L to less than 5 mg/L. They will use about 30 tonnes of aluminium sulfate per lake.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do these words mean as they are used in the passage? dissolved (line 1), fertilised (line 4), insoluble (line 12), precipitate (line 13).

2. a) What is the most probable source of the phosphate salts in the lakes?
   b) What are other possible sources of mineral salt for land locked lakes?

3. Why are the algae able to grow so rapidly?

4. a) Explain the solution to the problem as proposed by the Water Pollution Research Institute.
   b) If you can, write a chemical equation for the chemical process involved.

5. Why will conditions in the lakes become more suitable for other creatures? What particular conditions will improve? What might the other creatures be?

RESEARCH QUESTIONS

6. What is sediment? How is it formed? How is it classified? What eventually happens to sediment?

7. 'blooming' (line 4), is a specific term in biology. Find out what it means in this context, and describe the conditions necessary for an 'algae bloom'.

8. a) What do the letters mg/L mean: Exactly how much is a mg?
   b) A cup of tea which has been sugared with one spoonful of sugar contains about 12g/L. How does this compare with the phosphate concentration in the lake of 60mg/L?
   c) How much more than 12g is 30 tonnes?

★★★

SOURCE: "Life" Science Library: "Water", p.9. Time Inc., 1972.

THE PROPERTIES OF WATER

24

As a substance, water is odourless, colourless and tasteless. Yet it plays an unusual role in the affairs of the world because the seeming insipidity of its properties is deceiving. As a chemical it is unique. It is a compound of great stability, a remarkable solvent and a powerful source of chemical energy. It draws away from most organic substances but is strongly attracted by most inorganic materials, including itself; in fact, its own molecules cling together more tenaciously than those of certain metals. When frozen into a solid it expands, instead of contracting as nearly all other substances do, and the lighter solid floats on the heavier liquid - with astonishing consequences. It can absorb and release more heat than most common substances. In many physical and chemical properties - such as its freezing and boiling temperatures - water is an oddity, an exception to the rules. And nearly every one of these exceptions is woven into the fabric of human life, either naturally, as in the process of digestion, or artificially, as in the steam engine.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? odourless (line 1), insipidity (line 3), stability (line 4), solvent (line 4), tenaciously (line 8), consequences (line 11).

2. Why does the author say that water is an oddity (line 13)?

3. What is meant by the fabric of human life (line 15)?

4. Make a list of the ways in which water is "a unique chemical" (line 3).

5. This passage tells us that
   A. water is attracted to most organic and inorganic substances.
   B. water is attracted to most organic substances and repelled by most inorganic substances.
   C. water is repelled by most organic substances and attracted by most inorganic substances.
   D. water is repelled by most organic and inorganic substances.

RESEARCH QUESTIONS

6. Take ONE of the unusual properties of water. Find out more about it and write a one page report on it.

7. Take the unusual properties one by one. What would be the effects if that unusual property did NOT exist? Could we exist?

8. In the strict sense, there is a scientific error in line 8. Find it, and rewrite the sentence to remove the error.

9. What are the differences between physical and chemical properties (line 12)?

★★★

SOURCE: Science Journal

TAPPING FRESH WATER FROM THE AIR

25

NEW YORK CITY: An inexpensive method of drawing fresh water from the air to supply rain scarce regions with water has been proposed by Columbia University geologists, Robert D. Gerard and J. Lamar Worzel. The water could be obtained through condensation of moisture from humid maritime winds such as occur in most of the Caribbean islands and in other coastal regions of the world. Worzel and Gerard have suggested St. Croix in the U.S. Virgin Islands as one possible location for testing their method.

The proposed fresh water system would work as follows. Cold offshore ocean water could be piped to cool a condenser set up on the shore. As the humid winds strike the condenser, the resulting fresh water would be drawn off and stored. Worzel and Gerard calculate that a pipe slightly less than one metre in diameter running more than one and a half kilometres from deep water in the Virgin Islands Basin to a condenser would produce 4.5 million litres of fresh water daily. The cost could be kept low by using wind driven generators to produce electricity for pumping the ocean water to the condensers. Windmills were once successfully used in the Caribbean for sugar cane processing.

St. Croix, as well as other islands in the area, depends on wells and rainfall catchment for most of its water. The geologists explained that more than 1300 million litres of water (in the form of vapour in the lower atmosphere) sweep across Caribbean shorelines exposed to the trade winds, even on the driest islands. The advantages of their method over desalination processes include low operating cost and simplified equipment and procedures, as well as absence of brine as a harmful by-product.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What is the meaning of the following words as used in the passage?

   condensation (line 4) maritime (line 5) humid (line 5)
   catchment (line 21) desalination (line 25)
   brine (line 27) by-product (line 27)

2. Which island(s) were proposed for testing the new method?

   A. Caribbean Islands. C. Virgin Islands.
   B. St. Croix Island.

3. Why would the method proposed by the geologists be inexpensive?

4. What conditions are required for the successful operation of this new method?

5. Explain how the condenser (line 10) would work

6. Use a diagram to show how the method described in the article might be put into practice.

7. Would this method be useful for irrigating desert regions of the world? Explain.

RESEARCH QUESTIONS

8 (a) About how much water is required to fill an average Olympic swimming pool?
   (b) How many pools would be filled by 4.5 million litres of water?

9. An average person consumes (in drinking, washing etc) 50 litres of water a day. How many people would be able to live normally on the water supplied by the proposed programme?

EVAPORATION 26

Wet clothes are hung out to dry. Puddles on the road after rain soon disappear, and garden soil dries up in a drought. In these and similar cases the water that seems to vanish really *evaporates*.

As a liquid evaporates, it changes into an invisible vapour or gas. Water is made up of small particles called molecules. These are continually moving about and are held to each other by a force which we call cohesion. Some of the molecules of a liquid which is in an open container escape from this cohesion and jump from the surface into the air to form vapour.

The *rate* at which evaporation takes place depends mainly on the temperature. The hotter the liquid, the faster its molecules are moving. The faster they are moving the more easily they escape as vapour. The amount of surface open to the air also affects the rate. If a saucepan and a wide frying pan each holding one litre of water are set aside, the water in the frying pan will evaporate more quickly. The oceans are continually evaporating and then water vapour is blown over the land to 'fall as rain'.

Liquids such as petrol and methylated spirits evaporate quickly because the cohesion between their molecules is much less than that in water. These are called volatile liquids.

An important fact about evaporation is its cooling effect. Suck your finger and blow on it and it feels cold. This is because the molecules escaping as vapour take heat energy with them. In hot countries, water is often kept in earthenware pots. It soaks through the porous pot and evaporates from the outside. In doing this it takes heat from the water left in the pot, which is thus kept cool. The cooling effect of evaporation is used in refrigeration.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. All ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do these words mean as they are used in the passage?
   molecules (line 5), cohesion (line 6), rate (line 9), volatile (line 19), porous (line 23).
2. What factors affect the rate at which a liquid evaporates? Can you think of any other factors, apart from those mentioned in the passage?
3. The boiling point of concentrated sulfuric acid is higher than 100°C. What could you say about the cohesive forces between its molecules?

RESEARCH QUESTIONS

4. Arrange the following substances in order of increasing strength of cohesive forces between their particles. Water, petrol, iron, air, sulfuric acid, mercury.
5. Explain briefly how a canvas water-bag, often hung on the front bumper bar of a touring car, helps keep the water in it cool. Would it be just as cool on the back bumper bar?
6. How does a refrigerator work? Use a diagram to help your answer, and note carefully where the cooling effect of evaporation is used.

SOURCE: "Life Science Library", "The Scientist" ★★

Is Science Still Science? 27

Not long ago the word "science" called to mind a quiet backwater in which solitary men pursued their own special way of thought. Today it more often suggests vast installations, multi-million-dollar expenditures and a compelling voice in national [illegible]cy. Science in sport has become an establishment.

Big science dates from the 1940's and most directly from the crash program to build the A-bomb. At the time, the physicists who took part viewed their work as a patriotic chore which would end with the war. Their attitude towards bigness and organisation was expressed in this song:-

Take away your billion dollars, take away your tainted gold,
You can keep your damn high voltage, cause my soul will not be sold
Take away your Army generals, 'cause their kiss is death, I'm sure.
Everything I build is mine now. Every volt I make is pure
Engineering isn't Physics. Is that absolutely plain?
Take, oh take your billion dollars, let's be physicists again.

After the war, the scientists returned to their modest laboratories and dusted off their low-voltage apparatus. Once more they set about practising physics in the low-budget-pre-war tradition of "do-it-yourself"...of calculations done without computers, and of experiments with baling-wire and sealing wax. But the old ways were not to be recaptured. High voltages and team work were indispensable for many lines of research. Equipment for studying atomic nuclei required massive amounts of engineering and finance.

National defences continued to take a tithe of time and talent from every physics faculty. The H-bomb had to be built. So did the radar warning systems, the nuclear submarines, the missiles, the reconnaissance satellites. In the process the field of physics grew out of all proportion with the past. To a lesser extent most of the other sciences did the same.

It seems that the days of quiet, private research are over. The science of today is different to the science of yester-year.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as used in the article?

   solitary (line 2), establishment (line 5), modest (line 18), indispensable (line 23), engineering (line 25), satellites (line 29).

2. What do these phrases mean as they are used in the passage? Explain in detail.

   a) Engineering isn't Physics (line 16).
   b) baling-wire and sealing wax (line 22).
   c) National defences continued to take a tithe (line 26).

3. Why did science change after 1940?

4. Describe the main differences between pre-1940's and post-1940's science (are the post-1940's methods of science any different?)

5. What is the main theme of this article?

RESEARCH QUESTIONS

6. What types of equipment are used by scientists today to study atomic nuclei? See if you can find the names of five pieces, and the purpose of each.

7. The atom bomb changed physics. Have Astronomy, Chemistry, Biology and Geology changed in a similar way? See if you can pinpoint a change in these studies. In each case, what was the stimulus for the change?

SOURCE: "New Scientist", 14 December, 1978, pp.866 & 868. ★★★

SCIENTISTS MUST WRITE

28

Just as every French soldier carries a field marshal's baton in his knapsack, so every budding scientist and engineer should prepare for later fame by purchasing a copy of this book. This advice will be easier to follow when a cheaper edition becomes available.

Scientists learn to write by the combined effects of education, practice, criticism and constant seeking for improvement - in the same way as everyone else. Unfortunately they often lack one or more of these components. This book is not a substitute for a proper development, but it will help to repair deficiencies if it is first read and later referred to frequently. It deals with the minutiae rather than the grand design ...

... There are timely warnings against grandiloquence, verbosity and circumlocution, the use of jargon, blinding (self and reader) with science, and sticking to pedantic practices.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is meant by the expression "every French soldier carries a field marshal's baton in his knapsack"?
   A. French soldiers must carry things for officers.
   B. French soldiers should be ambitious.
   C. Most French soldiers will be field marshals.
   D. There is no harm in being prepared for the best to happen.

2. What is the meaning of minutiae (line 10)?
   A. Small details.
   B. Records of meetings.
   C. Recording times.
   D. Small animals.

3. What is the meaning of the expression "blinding with science" (lines 13 and 14)? If possible, give an example of this.

4. What does the author mean by the grand design (lines 10 and 11)?

RESEARCH QUESTIONS

5. Who first said "every French soldier carries a field marshal's baton in his knapsack"? When and why was it said?

6. Write a short passage which includes grandiloquence, verbosity, circumlocution, jargon, blinding with science, and pedantic practices. A suitable topic might be "Why am I a good scientific writer?" (Note: It is not expected that you will get all of these in one sentence.)

7. From what type of article was this extract taken?

SOURCE: C.P. Snow : "The Two Cultures", Mentor Books, 1963. ★★★

29a

THE TWO CULTURES

But what about the other side? They are impoverished too -- perhaps more seriously, because they are vainer about it. They still like to pretend that the traditional culture is the whole of "culture", as though the natural order didn't exist. As though the exploration of the natural order was of no interest either in its own value or its consequences. As though the scientific edifice of the physical world was not, in its intellectual depth, complexity and articulation, the most beautiful and wonderful collective work of the mind of man. Yet most non-scientists have no conception of that edifice at all. Even if they want to have it, they can't. It is rather as though, over a vast range of intellectual experience, a whole group was tone-deaf. Except that this tone-deafness doesn't come by nature, but by training, or rather the absence of training.

As with the tone-deaf, they don't know what they miss. They give a pitying chuckle at the news of scientists who have never read a major work of English literature. They dismiss them as ignorant specialists. Yet their own ignorance and their own specialisation is just as startling. A good many times I have been present at gatherings of people who, by the standards of the traditional culture, are thought highly educated and who have with considerable gusto been expressing their incredulity at the illiteracy of scientists. Once or twice I have been provoked and have asked the company how many of them could describe the Second Law of Thermodynamics. The response was cold: it was also negative. Yet I was asking something which is about the scientific equivalent of: *Have you read a work of Shakespeare's?*

I now believe that if I had asked an even simpler question -- such as, What do you mean by mass, or acceleration, which is the scientific equivalent of saying *Can you read?* -- not more than one in ten of the highly educated would have felt that I was speaking the same language. So the great edifice of modern physics goes up, and the majority of the cleverest people in the western world have as much insight into it as their neolithic ancestors would have had.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do the following words mean as they are used in the article? culture (line 3), edifice (line 6), conception (line 8), gusto (line 19), thermodynamics (line 21), insight (line 29).

2. What is meant by the other side (line 1)? Who are they?

3. What is meant by the illiteracy of scientists (lines 19 and 20)? Is this the usual meaning of illiteracy?

4. How can there be such a thing as ignorant specialists (line 15)?

5. What tone description would you give to this piece of writing? Sarcastic? Angry? Persuasive? Something else? What?

6. In four or five lines, state the main theme of this argument.

RESEARCH QUESTIONS

7. Find out what tone-deafness is. Is it a good comparison for C.P. Snow to have used?

8. What is the Second Law of Thermodynamics? Why does Snow think it is as important as a work by Shakespeare?

9. Why are mass and acceleration to science as reading is to English? Are the questions on lines 24 and 25 valid?

10. What is a neolithic ancestor? Do only clever people have them?

11. Is Snow being fair to non-scientists? Explain your view.

12. What special qualifications does C.P. Snow (now Lord Snow) have for making comments in this field?

13. What evidence is there of two cultures in your school?

★★★

SOURCE: C.P. Snow "The Two Cultures - a Second Look", Mentor Books, 1963. (This is the second of two selections, and should be read after the first selection.)

THE TWO CULTURES - A SECOND LOOK

30a

... I have regretted that I used as my test question *What do you know of the Second Law of Thermodynamics?* ...

I should now put forward a branch of science which ought to be a requisite in the common culture, certainly for anyone now at school. This branch of science at present goes by the name of molecular biology ... Through a whole set of lucky chances, this study is ideally suited to fit into a new model of education. It is fairly self-contained. It begins with the analysis of crystal structure, itself a subject aesthetically beautiful and easily comprehended. It goes on to the application of these methods to molecules which have literally a vital part in our own existence -- molecules of proteins, nucleic acids: molecules immensely large (by molecular standards) and which turn out to be of curious shapes, for nature, when interested in what we call life, appears to have a taste for the rococo. It includes the leap of genius by which Crick and Watson snatched at the structure of DNA and so taught us the essential lesson about our genetic inheritance ...

It exemplifies, with extreme neatness, some of the characteristics of the whole scientific culture, its subdivisions and its community. Exponents of the "two thousand and two culture" school of thought will be glad to hear that only a handful of people in the world -- five hundred? -- would be competent to follow in detail each step of the process by which, say, Perutz and Kendrew finally disentangled the structure of the haem proteins. After all, Perutz was at haemoglobin, on and off, for twenty-five years. But any scientist with the patience to learn could get instructed in those processes, and any scientist knows it. The great majority of scientists can acquire an adequate working knowledge of what the results mean. All scientists without exception accept the results. It is a nice demonstration of the scientific culture at work.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as they are used in the passage?
   aesthetically (line 9) rococo (line 14) subdivisions (line 19) culture (line 19)

2. What does Snow mean by molecules immensely large (by molecular standards) (line 12)?

3. What is an adequate working knowledge (line 28)?

4. The exponents (line 20) of a view, are people who

   A. believe the view.
   B. doubt the view.
   C. oppose the view.
   D. support the view.

5. What word best describes the tone of this passage?

6. C.P. Snow coined the phrase "the two cultures" to describe our society's scientific and non-scientific cultures. What do you think he means by "the two thousand and two culture" school of thought (line 20)?

7. How well qualified is Snow to discuss the "scientific cultures"? Explain why.

8. How well qualified is Snow to discuss the "literary culture"? Explain why.

9. Professor Bill Williams says that Australia has three cultures. He described them on ABC Radio in 1974. Find out more about them, and how they fit in with Snow's "cultures".

10. What does the Second Law of Thermodynamics say and mean?

★★★

SOCIAL DARWINISM

31

Herbert Spencer was a sociologist, not a biologist. He was the leader in applying biological thinking to human social behaviour. He had read Malthus, and so was ready for the ideas of Darwin when they came. What he did, however, was to develop Darwin's ideas into what is now known as Social Darwinism. This is a line of thinking which argues that the principles which apply to the evolution of organisms apply also to the evolution of societies. A typical example of Social Darwinism is the argument of General von Bernhardi and other generals in favour of war. A nation's fitness to survive can be measured by war, the supreme agent of the evolutionary process, they say. Or we might take the example of John D. Rockefeller, who certainly should have known. He said "The growth of a large business is merely the survival of the fittest".

To those who misused it, Darwinism was offered as no mere apology. It was more positive than that, it was a validation, a biological justification for competition. This doctrine has become part of the behavioural equipment of our civilization. It is part of the system of overt beliefs of almost everyone in the Western world today. And so, in the Middletowns of today, we find our typical businessman saying: "You can't make the world all planned and soft. The strongest and the best survive - that's the law of nature after all - always has been and always will be."

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean, as they are used in the article?
   typical (line 7) supreme (line 9), positive (line 15)
   validation (line 15), doctrine (line 16) overt (line 17)

2. From the information supplied here, describe in your own words what Social Darwinism is.

3. Middletowns (line 18) refers to
   A. the suburbs.
   B. inland towns.
   C. the middle classes.
   D. medium-sized towns.

RESEARCH QUESTIONS

4. Who was the first person to use the phrase "survival of the fittest"? *(This is something of a trick question.)*

5. Why did the author say that Rockefeller certainly should have known (line 11)?

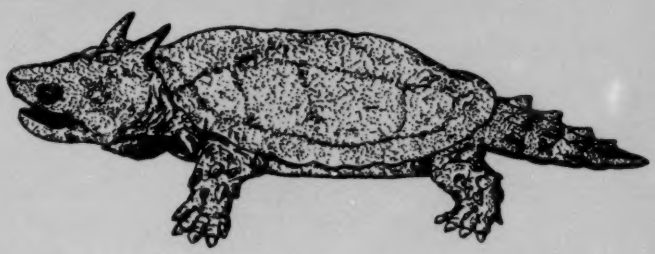
6. How do biologists measure fitness to survive (line 9)?

7. Biologists (and others) say that the reasoning behind Social Darwinism is faulty. Find out why. (You could start by asking how non-aggressive animals survive.)

SOURCE: "Sun-Herald"

SOLVED: MYSTERY OF THE HORNED TURTLE

32a



The fossilised remains of a strange horned turtle which roamed the world about 80 million years ago have been found on Lord Howe Island.

The complete shell and skull of the turtle are undergoing final cleaning and preservation treatment at the Australian Museum in Sydney before being put on display.

The museum's curator of fossils, Dr. Alex Ritchie, found the specimen on a recent expedition to the island, 640 km north-east of Sydney. It is the most complete one of its kind ever unearthed.

Meiolania platyceps, to give it its scientific name, was the last survivor of a family whose history stretches back to the end of the age of dinosaurs, the Cretaceous period.

The turtle was one-and-a-half to two metres long, with a large, broad shell and a distinctive head and tail.

The skull was sub-triangular, with the eyes set far forward. The rear corners of the head bore prominent solid, bony horns, sharp-pointed and often curved like those of a young calf.

The horns prevented the head being retracted into the shell.

The tail was encased in an inflexible bony sheath, armoured along the top and sides with pairs of blunt, bony spikes.

Dr. Ritchie believes the turtle was basically a land-living animal, whose habits were probably similar to those of the giant land tortoises of the Galapagos Islands.

The first bones of *Meiolania platyceps* were discovered in the rocks of Lord Howe in the 1870s and 1880s. There were more finds in 1920, 1959 and 1971, but none produced a whole skeleton, only individual bones.

Locating and digging out finds of *Meiolania* is no easy task.

Mr. Jim Dorman, president of the Lord Howe Island Historical Society, is Dr. Ritchie's chief "scout" for new fossils.

Mr. Dorman urged Dr. Ritchie to visit the island in October to examine the turtle fossils he had found.

On this visit, Dr. Ritchie discovered the palaeontologist's "pot of gold" - his first almost complete skeleton.

Removing from the cliff-face the great slabs of rock in which the fossil was embedded meant lugging a generator and jackhammers to the excavation site on Old Settlement Beach.

The weighty rock slabs then had to be air-freighted to the museum in Sydney, where Dr. Ritchie's assistant has spent the past two months delicately and painstakingly separating the fossilised skeleton from the rock.

Much of the world-wide interest in the fossils stems from the fact that *Meiolania* was the last survivor of an ancient group of horned turtles recorded in the late Cretaceous and early Tertiary rocks of South America.

Fragments have been found in south-east Queensland, Gulgong and Coolah (N.S.W.) and on Walpole Island, 170 km south-east of New Caledonia.

Dr. Ritchie believes the horned turtles of Lord Howe died out in relatively recent times - about 30 000 years ago.

Now he is pondering such questions as when and how the turtle reached such an isolated spot as Lord Howe, how long it flourished there and why it died out.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do the following words mean as used in the article?
preservation (line 5), curator (line 7) distinctive (line 14)
prominent (line 16), retracted (line 18), encased (line 19)
palaeontologist (line 32) lugging (line 35)
flourished (line 51)

2. Other fossilized remains of the horned turtle have been found before. Why should this find be so exciting to scientists?

3. The horned turtle which was found lived on earth during the Cretaceous period. About how long ago was this?

4. What are the horns and the spikes on the tail made of?

5. A student described the horned turtle as follows:
   (a) Horned turtles are living on Lord Howe Island.
   (b) The horned turtle is about the size of a cat.
   (c) It could tuck in its head under its shell by turning its head sideways.
   (d) It has an unbendable tail.
   (e) It lived on land and ate vegetation.
   (f) The horned turtle is blind.

   Some of these descriptions are wrong. Which ones are wrong? Correct the wrong descriptions and rewrite them in your book?

6. In what kind of material on Lord Howe Island was the turtle found?

7. Besides Lord Howe Island where else have remains of the horned turtle been found?

8. The diagram of the horned turtle is drawn one fifteenth its natural size. What is the length of the horned turtle in the diagram?

RESEARCH QUESTIONS

9. Using an atlas draw a map of the eastern part of Australia and including Lord Howe Island and New Caledonia. On the map mark, in red, the following places referred to in this article:
Lord Howe Island, New Caledonia, Gulgong, Coolah, Walpole Island.

10. Draw and name some other animals which lived during the Cretaceous period.

11. Why do scientists use scientific names? Why can't they just call *Meiolania platyceps* by its common name, the horned turtle?

★★

SOURCE: New South Wales Department of Agriculture, Biological and Chemical Research Institute Entomology Branch, Insect Pest Bulletin 111C, 1977.

33a

ARGENTINE ANT

(Iridomyrmex humilis)

ARGENTINE ANTS are the world's worst ant pest, being more persistent than any other species. They are practically omnivorous in their feeding habits, but may prefer sweet things. They may be found throughout the house, even in refrigerators and beds, but particularly in pantries,kitchens and dining rooms. The irritation and annoyance caused by their persistent infestation are harmful to human health, as can be their unhygienic habit of invading garbage tins and rubbish heaps.

They are important orchard and garden pests because they protect sap-sucking insects such as aphids, scales, and mealybugs from their natural enemies. They also damage flowers when in search of nectar.

Hens may be driven from nests, especially when hatching begins or if an egg is broken in the nest. Newly-hatched chickens may be killed by the ants, and caged birds may also be attacked.

Like those of other ants, Argentine ant colonies contain queens, males and workers, and brood consisting of eggs, larvae and pupae. Workers are the most commonly seen and cause the actual damage and annoyance; but, at times, queens will travel along well-defined trails, probably to a new nest site. When crushed, they do not give off the formic acid smell so characteristic of many other species of ants, but may have a musty or greasy odour. They cannot sting, but may bite if their movement is restricted. Eggs hatch in from 12 days to nearly 2 months. The larval stage occupies 11 to 60 days, and the pupal period from 10 to 25 days. The minimum period from egg to adult is about 1 month, but it may take 4 to 5 months.

Nests usually are made near food sources, but seldom inside or under buildings. They are found in lawns, alongside paths, gutters and kerbings, under garbage cans, pieces of iron, rubble, waste cloth of paper, in damaged fences and streeth poles, brickwork of houses, compost heaps, raised areas of soil in low-lying land, and sandhills. The nests are generally shallow, often no more than 2.5 cm from the surface.

Argentine ants rarely tolerate other ant species, which makes it comparatively easy to delimit an infested area, and their natural spread is fairly slow. They cannot found a colony unless at least one fertile queen is present. Transport, even in large numbers, of workers only is not sufficient to initiate a new colony in a new district.

ARGENTINE ANT ERADICATION CAMPAIGN

Some 337 areas of infestation, covering more than 3400 hectares have been sprayed to October, 1976, in the Argentine Ant Eradication Campaign.

Occupiers of land are required by law to notify their local Council immediately they are aware of or suspect the presence of Argentine ants in or upon such land.

A reward of $100 is paid to the first person reporting a new area of infestation. Whilst awaiting treatment by an official spray team, it is recommended that a spray of 2 per cent chlordane emulsion by applied to the whole of the outer foundations of the house or other buildings. Additionally the remainder of the property should be sprayed to form a grid of barriers. about 10 cm wide and no more than 1.8 m apart, between food and the nest site. Garbage tins and their surrounding area should be thoroughly sprayed.

Inside the house the emulsion should be painted on all skirting boards, bases of cupboards, refrigerators, legs of tables, window sills, or over an area on which ants may trail, but which are not likely to be contacted by foodstuffs, children, and pets.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do the following words mean as used in this article?
   persistent (line 1)
   omnivorous (line 2)
   infestation (line 6)
   unhygienic (line 7)
   nectar (line 11)
   brood (line 16)
   musty (line 21)
   eradication (line 37)
   emulsion (line 45 and 51)

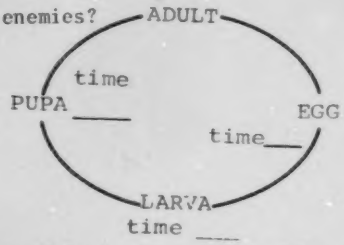
2. Why would Argentine ants be found more particularly in pantries, kitchens and dining rooms than in refrigerators or beds?

3. In what ways are Argentine ants a pest to man?

4. (a) In an area which is infested by Argentine ants will the numbers of aphids and scale insects increase or decrease? How do you know?
   (b) How will this affect the local environment?

5. (a) Do Argentine ants have a stinger?
   (b) What weapon do they use to attack their enemies?

6. Copy this simplified diagram of the life cycle of the Argentine ant. On the diagram you have drawn, write in the approximate times a developing Argentine ant would spend at each of the three stages before it became an adult.



7. (a) If an Argentine ant developed from egg to adult in the *minimum* time, what *percentage* of time would it spend at each of the stages egg, larva, pupa?
   (b) What do you notice about these percentages?

8. On your diagram to question 6 mark with an asterisk (*) the stage where you find the males and workers.

9. What *three* characteristics would you use to distinguish Argentine ants from other ant species?

10. What must Argentine ants have before they can start a new colony?

11. Why are land owners required, by law, to notify authorities if they discover Argentine ants on their property?

12. What is the purpose of spraying chlordane emulsion at different places around the property?

RESEARCH QUESTIONS

13. Using library sources find out more about the life cycle of Argentine ants. What are the functions of (a) queens; (b) males; (c) workers?

14. Are Argentine ants native to Australia? If not, where did they come from, and how and when did they arrive here?

SOURCE: "Everything Has a History", J.B.S. Haldane, and Unwin, 1951.

★★

MOVIES FOR TOADS. 34a

Another of Dr. Honigmann's experiments was probably still more interesting. It has often been stated that animals cannot appreciate pictures. Certainly they recognize gramophone records. And female crickets will come to a telephone if a male of their species is chirping at the other end. But a dog rarely, if ever, shows any interest in a picture or photograph of his master or another dog. Nor is he interested in cinema films.

The first animals which undoubtedly reacted to a moving picture are the common toad and the natterjack toad. They have very simple minds, if mind is the right word. They will only eat moving objects. The response to food is very characteristic. Although it is slow in its ordinary movements, a toad can flick out its tongue with very great speed and accuracy, and bring back a small insect or other food into its open mouth. It then swallows it if the taste is suitable. They are not interested in dead mealworms if they stay still. But a toad will flick and snap at a dead mealworm if it is dragged past the toad, especially if there is a well-marked background behind it. The toad snaps in the same way if the mealworm stays still, and the toad and the background are dragged past it. Toads will also snap at a film of a moving mealworm or other small animal. It might be argued that they react mechanically to any small object which moves or seems to be moving. But this is not the whole story.

If two toads are competing for the same food, and one of them gets it, the disappointed toad, especially if hungry, may flick its tongue at the eye of its successful rival. This is particularly common if the successful toad is the smaller of the two. Honigmann made films of toads eating, and showed them to other hungry toads. I have myself seen them flicking the film star in the eye with their tongues. But this is most constantly done if the film is shown a little less than life size, and rarely happens if it is enlarged. The toad is not a noble animal. A toad will attack a picture of itself feeding as readily as that of another toad, but it is quite uninterested in films of other small animals such as hamsters, feeding.

Encouraged by his success with toads, Honigman went on to show his films of moving worms to dragonfly larvae. These live under water, and shoot out their jaws at their prey. The film had to be shown projected onto a sheet of white paper pasted on the side of a glass tank, and the insects snapped at the pictures.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as used in the article?

   undoubtedly (line 8), characteristic (line 11), accuracy (line 13), mechanically (line 21), noble (line 31), readily (line 31)

2. What does Haldane mean by if mind is the right word (line 10)?

3. Why do toads only eat moving objects (line 10)?

4. If toads only eat moving objects (line 10), why is it that the toad snaps in the same way if the mealworm stays still, and the toad and the background are dragged past it (lines 18 & 19)?

5. Why do scientists study "simple" animals like toads and dragonflies?

6. Why might toads prefer to attack other toads smaller than themselves (line 26)?

RESEARCH QUESTIONS

7. Find out more about J.B.S. Haldane (John Burdon Sanderson Haldane). Was he a journalist, a scientist or what? Why did he write scientific articles like this one?

8. Has any work been done since on animals which can see (and react to) motion pictures? Name at least one other animal which does so.

SOURCE: "Australian Wildlife" by Alec H. Chisholm ★★

MONOTREMES : ANIMALS THAT LAY EGGS

35a

The platypus and spiny anteater both produce soft-shelled eggs, like those of reptiles. However, in contrast with the anteater, which limits itself to one at a time and deposits it in a rudimentary pouch, the platypus constructs an elaborate burrow with a substantial nest at the end, and there lays two or three eggs. Each of these, as an astonishing fact, is only about the size of a sparrow's egg, and only a fortnight is occupied in hatching, a period no longer than the breeding time of a small bird.

In spite of a lower rate of reproduction, the anteater is much more widely distributed than its "cousin". It occurs over much of the mainland and Tasmania, and in New Guinea there are at least two other kinds, each with a very long snout, which is probably an adaptation for probing in the damp humus of tropical highlands. The platypus, on its part, is limited to streams in Tasmania and along the continental east coast only as far north as the Atherton Tableland.

Possibly the prosperity of the anteater has been due, in large degree, to its defensive equipment. It has a formidable array of spines, and the extraordinary ability to dig almost out of sight, even in hard grounds, before you can say *Tachyglossus aculeatus*! The platypus, however, is also skilled at disappearing smartly (in water), and in addition the male has a notable defensive mechanism. It has a poison-spur about half an inch long, on each hind leg, which is capable of killing a dog and making a human being quite ill.

Both the platypus and the anteater were discovered by settlers at an early period - in the 1790s. The anteater became know then as the native porcupine and echidna (a name really belonging to a group of eels), and the platypus was first termed water mole and duckbill. The strange "water-mole", in particular, captured public attention. Apart from its fantastic appearance - which caused some abroad to regard specimens as stitched-up fakes! - its egg-laying habit, as first reported by Aborigines, was not definitely resolved until 1884, when W.H. Caldwell, a young scientist from Scotland (via Cambridge), spent a considerable time in Queensland investigating the breeding behaviour of both monotremes.

Meanwhile, the platypus had been much hunted for the sake of its soft fur. As late as 1884, when Caldwell made his announcement, a Sydney firm of furriers declared that it had hunters "in various parts of the colony all the year round". It made this statement while disputing the egg-laying evidence, its own idea being that platypuses "spawn like frogs"!

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as they are used in the above passage?
   rudimentary (line 3), elaborate (line 4), substantial (line 4), adaptation (line 12), prosperity (line 16), formidable (line 17).

2. How many eggs does the platypus lay?

3. Why is the size of the platypus' egg an astonishing fact (lines 5 and 6)?

4. Where does the anteater put its egg?

5. Why does the anteater dig in the damp humus of the highlands in New Guinea?

6. What made the Sydney furriers declare that Platypuses spawn like frogs (line 38)?

7. Why did men overseas regard specimens as <u>stitched-up fakes</u> (line 30)?

8. How do the platypus and the anteater attempt to escape their enemies?

9. Who first reported the egg-laying habits of the platypus?

10. In what ways are platypuses and anteaters related but different?

11. What is another name for the anteater?

12. Why is the word <u>cousin</u> enclosed in quotation marks in the passage (line 10)?

RESEARCH QUESTIONS

13. Without looking up the expression *Tachyglossus aculeatus* what would you guess it to mean? Now find out what it means!

14. Draw a map of Australia, and on it shade in the areas where the platypus and echidna live. Use different colours for each.

* * * * * * * * * * * * *

FOOTNOTE: The correct plural form of "platypus" is "platypodes", but "platypuses" is also acceptable.
"platypi" is <u>not</u> correct.

★★

SOURCE: Adapted from "The Wombat", The Australian Museum Leaflet No. 34, June 1969.

THE WOMBAT 36a

Wombats are normally solitary animals, although the hairy-nosed species in South Australia lives in communal burrows. They are mainly nocturnal, and do not emerge to feed until after dark; they return to their burrows before dawn. These burrows, which are excavated with powerful claws of the forefeet, are usually built under the roots of a tree or in a bank in the case of the Common Wombat, and under limestone shelves in the case of the hairy-nosed species. The Common Wombat makes quite characteristic runways through the undergrowth of the forest, and often deposits small piles of dung on prominent objects, such as rocks or logs, which lie along its pathway. This may be a method of marking its "territory".

Adult female hairy-nosed wombats have been examined in the Murray River district of South Australia. These had large naked juveniles in the pouch which were estimated to be about 3 months old. It was therefore thought that mating would have taken place in the late spring (November), and the single young would have been born in late December or early January. The pouch is large and deep and contains two teats. The young remain in the pouch for about 5 months.

The average age wombats attain in captivity is 11 years, but it is probable that they do not live as long in their natural state.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do the following words mean as used in this article? solitary (line 1), communal (line 2), nocturnal (line 3), excavated (line 5), forefeet (line 5), runways (line 9), prominent (line 10), juveniles (line 14).

2. The wombat is a marsupial. What evidence is there for this in the article?

3. List two characteristics which make the Common Wombat and the hairy-nosed wombat different.

4. Name two characteristics which the Common Wombat and the hairy-nosed wombat have in common.

5. If you saw a Common Wombat in the Eucalyptus mountain forests of the Blue Mountains, you would most likely believe that it lived
   A. alone.
   B. in small family groups.
   C. in large family groups.
   D. in small communities.

6. The adult female hairy-nosed wombat which was examined along the Murray River district was most likely caught in

A. early April.
B. early June.
C. late September.
D. late November.

7. During which month would the young wombat mentioned in this article have left its pouch?

8. The length of time that the female hairy-nosed wombat would have been pregnant for is closest to

A. 3 weeks.
B. 5 weeks.
C. 3 months.
D. 5 months.

9. Why do you think that the author believes that wombats do not live as long in their natural state as they do in captivity?

RESEARCH QUESTIONS

10. The wombats belong to the same group as the kangaroos and possums. What characteristics do they have in common?

11. What characteristics makes the wombat unique in the mammal world?

12. Why are wombats sometimes called "marsupial bears"?

SOURCE: Adapted from Science Journal, October 1966. ★★★★

BATS' BIOLOGICAL TIME CLOCK

37a

Researchers at the Argonne National Laboratory in Illinois are exposing brown bats to different wavelengths of light in the hope of learning more about the biological 'time clock' of mammals.

The experiment involves placing the bats in cages lit by blue, red, yellow and green light. The researchers hope to learn if specific wavelengths of coloured lights are detected by bats and how the lights affect their daily activity and body rhythms. Previous experiments have shown that bats will adjust their body functions to conform to changing white light sources. However, the effects of coloured lights on bats remains a mystery.

The researchers chose bats for the experiment because the bat has a biological rhythm that is extremely precise. It has been found that the best way to study the bats biological time clock is to record the mammal's variations in body temperature. This is done by implanting sensitive thermocouples under the animals' skin. When inactive and fasting, the bat's body temperature is normally only a few degrees above the environmental temperature. However, when the bat is active and feeding, its temperature can reach 58°C.

The study of biological rhythms in physiological and behavioural functions of organisms is a relatively new area of scientific interest. Space scientists, for example, still need to know what effects the changing of normal day-night light cycles have on human astronauts.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is the meaning of these words as they are used in the article? conform (line 8), precise (line 11), implanting (line 13), sensitive (line 13), cycles (line 20), physiological (line 17).

2. Bats were chosen for this series of experiments because they
   A. react to changes in white light.
   B. have a very accurate "biological clock".
   C. are examples of mammals.
   D. are of particular scientific interest.

3. The physiological changes in the bats were measured by recording
   A. different wavelengths of light.
   B. red, yellow, blue and green light.
   C. its precise biological rhythm.
   D. variations in body temperature.

4. What does the thermocouple mentioned in the article measure?
   A. Biological patterns.
   B. Day-night cycles.
   C. The wavelength of the light.
   D. Body temperature of the bat.

5. What is meant by a biological time clock (line 3)?

RESEARCH QUESTIONS

6. Why do you think this experimental study is relevant to astronauts?

7. Find out more about wavelengths (line 2) particularly of light. What are the wavelengths of red, green, blue and yellow light? How does wavelength relate to frequency? What is frequency? How does the visible spectrum relate to wavelengths of light?

8. What use is it to the bat to have a wide range of body temperatures? How would it affect humans if they had a similar range? (Humans usually have a temperature very close to 37^{0}C.)

SOURCE: Adapted from Science Journal, June 1968. ★★★

38a

DEER ANTLERS MAY ACT AS RADIATORS

A zoologist at the University of Canterbury has produced evidence to support his theory that the antlers of stags act principally as radiators for dissipating excess heat during the rutting season.

Dr. B. Stonehouse measured temperature changes in the antlers by anaesthetizing the deer and fitting a radio thermometer to the antlers.

He found that when the deer is active, particularly in the sunlight, the temperature on the surface of the antlers rises to bloodheat. When resting or in the shade, or sitting down to ruminate or sleep, the antler temperature drops markedly.

By exhibiting different behaviour patterns, the stags can turn their antlers on or off. They move in the shade as much as possible, and are mainly nocturnal animals.

Stonehouse explains these observations in terms of physiological variations during the seasons of the year, ecological observations, and the anatomical details of the vascular system.

He questions the classical explanation of antlers as being symbols of maleness, or for fighting. He points out that stags seldom fight each other, and in any case antlers are the wrong shape and in the wrong place for fighting. Further, he says they are biologically too expensive as they consume considerable amounts of energy growing anew each year.

The six months gestation period is one of the operative factors. Throughout pregnancy the female keeps her weight down by diverting excess energy into the growing foetus, and later by feeding the fawn.

The stag, however, lays on a layer of excess fat during spring and summer. This acts as an insulating blanket and prevents the stag from losing heat to the environment through the normal surfaces as rapidly as required.

Stonehouse postulates that the stags have evolved natural radiators at the most effective place and at the required time. Like all mammals, deer lose much heat through the top of the head where the veins and arteries are well developed.

When he needs to radiate more heat than usual, the stag grows an extra radiating surface from his forehead using extension of the existing veins and arteries into the velvet of the antlers. Antlers act as radiators only while they are growing, and by the end of their growth this requirement has been fulfilled. Finally, Stonehouse points out that the colour of the velvet aids its efficiency as a radiator.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article?
dissipating (line 3), ruminate (line 8), nocturnal (line 12), physiological (line 13), classical (line 16), operative (line 21), excess (line 24), postulates (line 27).

2. (a) What is Dr. Stonehouse's theory?
(b) What is his evidence for the theory?

3. Why is the top of the stag's head the most effective place (line 28) for antlers? Effective for what?

4. What is meant by biologically too expensive (line 19)?

5. The stag puts on a layer of fat in spring and summer. The female does not.
   (a) Does the fat layer give the male any biological advantage?
   (b) If the fat layer does give an advantage, how does the female manage without the fat layer?

6. A female deer is called a
   A. doe. B. fawn. C. foetus. D. stag.

7. Explain in your own words the meaning of paragraph 5. ("Stonehouse explains ..... vascular system") (lines 13 to 15)

8. Why did Dr. Stonehouse need to anaesthetize the deer (lines 4 and 5)?

RESEARCH QUESTIONS

9. (a) What is the gestation period of a deer?
   (b) What is the gestation period of a human?

10. Why should the stag require another way of losing excess heat?

11. Why does the female deer NOT need to grow antlers to dissipate the excess heat?

12. Explain how the shape and structure of the antlers would make them efficient radiators of heat.

SPECIAL QUESTIONS ABOUT DEER

13. What is the rutting season (line 3)?

14. When does it occur (what season of the year)?

15. What is the velvet mentioned in the last paragraph? What does it do?

★★★

FOSSIL SKULL 39a

A whole skull belonging to the oldest known member of man's family tree - an ape that lived some 28 million years ago - has been found in the Egyptian desert. The discovery of this new and best example yet of *Aegyptopithecus zeuxis* was announced by Professor Elwyn L. Simons of Yale University's Peabody Museum. He has been digging since 1961 in Egypt's Fayum Desert, where the skull was found. "Not only is the skull some eight million to ten million years older than any previously uncovered but it is better preserved than any fossil related to man that are older than 300 000 years," said Simons. Recently, Peabody research associate Grant E. Meyer was exploring the site when he caught sight of a frontal bone, exposed by erosion, some 90 metres below the top of a lava flow. He shipped the skull, still in its encasing rock, to the museum. There, painstaking removal of the rock revealed that it was in remarkable condition. Portions of the skull's top and bottom were missing, as are four incisor teeth; otherwise it is relatively complete.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What is the meaning of related (line 10) as it is used?

   A. Belonging to the same family.
   B. A long dead relative of someone.
   C. A skull belonging to an ancient ape.
   D. Belonging to some ancestor of mankind.

2. What is the meaning of associate (line 11) as it is used in the passage?

   A. Assistant.
   B. Organiser.
   C. Partner.
   D. Superior.

3. What is the common name for the frontal bone (line 13)?

   A. Breast bone.
   B. Cheek bone.
   C. Forehead bone.
   D. Jaw bone.

4. Which teeth are the missing teeth (line 17)? Teeth which

   A. crush food up.
   B. cut food up.
   C. grind food up.
   D. tear food apart.

5. What is the most likely cause of erosion in the region where the skull was discovered?

A. Air.
B. Ice.
C. Water.
D. Wind.

6. What is the most likely cause of weathering in this region?

A. Chemical reactions.
B. Temperature changes.
C. Wind action.
D. Water in rocks.

7. Explain the difference between erosion and weathering.

8. Explain why the skull was shipped to a museum <u>still in its encasing rock</u> (line 15)

9. How old was the skull believed to be

A. 300 000 years.
B. 8 000 000 years.
C. 10 000 000 years.
D. 28 000 000 years.

10. How would you describe Professor Simons occupation or profession?

SOURCE: Science Journal March 1969. ★★★

DETECTING TOXIC GASES IN THE AIR

40a

A sophisticated device for detecting toxic materials in the air has evolved from the canary in a cage once carried by coal miners to indicate the presence of firedamp. According to British Patent 1 135 091 it consists of a transparent cell containing a culture of a luminous micro-organism such as *Photobacterium fischeri* over which is placed a sensitive photodetector.

If air contaminated with a toxic substance is passed through the cell the light intensity from the culture drops rapidly. When this happens the signal generated by the photodetector will set off an alarm. The bacteria quickly recover substantially all their original luminescence so that the detector may be re-used a number of times.

Under normal conditions, the luminescence of a colony of suitable bacteria rises during the early stages of growth and then diminishes. So the circuitry of the device must be able to compensate both for this drift and for any permanent damage caused to the colony by toxication. From time to time the colony has to be replaced when its luminescence becomes too weak to give a clear signal.

A particular advantage of this detector is its ability to detect an extremely wide range of toxic substances. Other more modern instruments are more limited, usually detecting only a single toxic substance.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the article? evolved (line 2), firedamp (line 3), cell (line 4), luminous (line 5), photodetector (line 6), contaminated (line 7), culture (line 8), toxication (line 16).

2. Explain what a Patent (line 3) is. Of what advantage is it to take out a patent?

3. What is used in the device to detect toxic substances?
   A. Bacteria.
   B. Canaries.
   C. Firedamp.
   D. Transparent.

4. What happens when the device is placed in air which contains toxic substances?
   A. The bacteria glow more brightly and an alarm is set off.
   B. The bacteria recover their original luminescence.
   C. The bacteria culture decreases considerably and an alarm is set off.
   D. Light intensity from the bacteria decreases and an alarm is set off.

5. What are two problems which have to be allowed for in constructing the device?

6. The new device is better than other instruments which detect toxic substances. Explain why this is true.

RESEARCH QUESTIONS

7. Use the library to make a list of the 10 main toxic contaminants of our environment. Alongside each list the main source(s) of these toxic substances.

8. Are there any authorities set up by the governments in Australia which monitor toxic substances in our air, water and foods? What are they, and what do they do? How is the information they obtain used, and by whom?

9. Do some research to find out how a "breathalyzer" works. Is the use of this device by police an infringement of our liberties? Should it be allowed or abolished? Give reasons.

10. How do living organisms, such as photobacteria, fireflies and glow-worms produce luminescence?

SOURCE: From "Sun-Herald" April 8, 1979, p. 139. ★

MUSHROOMS

41a

Research units in many parts of the world have been studying the culture of mushrooms in recent years.

As a result of those studies, we can now enjoy freshly picked mushrooms and save money by growing them at home.

One brand of mushroom spawn comes in "mini-farm" kits.

The mini-farm can be placed in a corner of the garage or other suitable shelter.

Darkness is not needed, but a draught-free position is required in a temperature of 15 to 18 degrees Celsius.

The kit consists of a large and small bag. Open the large bag and turn the side down to about 5 cm above the surface of the compost.

Flatten the surface of the compost by hand, and if dry, moisten it slightly.

Add the moist peat from the small bag, spread it evenly and cover with a sheet of moist newspaper.

During the next 10 to 14 days, keep the newspaper and peat moist (not wet) until the mushroom mycelium appears.

Water gently so as not to disturb the peat. (You should be able to squeeze a little water out of the peat after watering).

When the mycelium is in the surface of the peat, it will look like a mass of fine white hairs.

Then remove the newspaper and water gently to encourage the mycelium to pink up and form mushrooms. Fresh air (not draughts) helps the mushrooms to form.

Water more frequently from now on, but don't overwater.

When you pick a mushroom, twist it gently and lift it away from the bag with a minimum of peat.

Cut off the bottom of the stalk, wipe with a damp cloth; and the mushroom is ready for cooking.

If carefully tended, the mini-farm should continue producing mushrooms for two to three months.

When mushrooms fail to appear after 14 to 21 days, cropping is over, but you have a bag of compost for use in the garden.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is the meaning of the following words as used in the passage above?
   culture (line 2), compost (line 12), peat (line 14), mycelium (line 17), cropping (line 32).

2. Is it necessary that mushrooms be grown in the dark?

3. Under what conditions should mushrooms be grown?

4. Why should the peat be covered with a moist newspaper?

5. (a) About how many weeks after setting up the "mini-farm" will the mycelium appear?

5. (b) How can you tell when the mycelium has appeared?
   (c) Why is the newspaper removed at this stage?

6. (a) What is the recommended procedure for picking the mushrooms?
   (b) Why should you not pull them out?

7. For how many weeks will the "mini-farm" keep producing mushrooms?

8. How will you know when the "mini-farm" kit has exhausted its mushroom supply?

RESEARCH QUESTIONS

9. What type of a plant is a mushroom?
   Draw a diagram of a mushroom and label its parts.

SOURCE: Science Journal March 1969. ★★

SLOWING SUPERTANKERS 42a

The advent of supertankers in recent years has accentuated the difficulty of slowing down a moving ship in case of emergency. There are some ships which have a normal stopping distance of more than 10 km.

With this in mind the G.Q. Parachute Company Ltd. has proposed in British Patent 1 131 685 a method of slowing ships with water parachutes suspended on either side of the bows. The parachutes are arranged so that they can be used rapidly. Each has in front of the main canopy a further canopy made of net which will catch or deflect any wood or flotsam which might tear the fabric. The parachutes are held close to the sides of the ship. They can be reefed either singly to assist turning or together to reduce their braking effect.

The braking parachutes are also useful for hovercraft which have a similar problem in slowing down. In this case, however, conventional air parachutes might be adequate.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the article? advent (line 1), accentuated (line 1), suspended (line 7), canopy (line 9), flotsam (line 10), reefed (line 12).

2. Explain what a Patent (line 6) is. Of what advantage is it to take out a patent?

3. (a) Is the ship parachute used in the air or in the water? How do you know?
   (b) Explain fully how the parachute works.

4. Where will the parachutes be placed on the ships?
   A. Slung from the back, dragging behind the ships.
   B. At either side at the back of the ship.
   C. Either side at the front of the ship.
   D. On one side *or* the other at the front.

5. Why will air parachutes probably work with hovercraft?
   A. Hovercraft are much lighter than supertankers.
   B. The air parachutes are larger.
   C. More parachutes can be used on the hovercraft.
   D. Hovercraft travel much faster than supertankers.

6. What does the author mean in the last sentence by the statement conventional air parachutes might be adequate?

RESEARCH QUESTIONS

7. Explain exactly how these parachutes will work to
   a. slow down the supertankers.
   b. allow the supertankers to turn.
   c. allow an increase in speed.

8. Supertankers have an average speed of 25 kilometres per hour. If it takes 10 km for it to stop from this speed what is its deceleration?

9. Why does it take such a large distance to bring a supertanker to a halt?

SOURCE: "Brunel", by L.T.C. Rolt, Methuen, 1965, p.78.

BRUNEL THE SHIP-BUILDER

43

A few hours after leaving Liverpool and in pitch darkness, the Great Britain struck. Passengers rushed from their cabins in terror as they heard the ship pounding over rocks with a frightful grinding noise. No wooden ship could have withstood such a battering; it would probably have broken up with a great loss of life. But Brunel had given the iron hull such strength that everyone was able to remain on board in safety until dawn broke. Till then no-one knew where they were. At the time the ship struck, the Captain had supposed he was near the Isle of Man, but daylight revealed the mountains of Mourne. The Great Britain was high and dry on the beach in Dundrum Bay on the north-east coast of Ireland. The compass had been affected by the mass of iron in the hull and had given a false reading.

At low tide all the passengers and crew were brought to safety, but after one unsuccessful attempt to refloat her, she was abandoned by the Company as a total loss until Brunel himself managed to visit the scene in December. He was furious when he saw how little effort had been made to save his beautiful ship.

"The finest ship in the world", he told the Company, "has been left, and is lying like a useless saucepan kicking about on the most exposed shore that you can imagine, with no more effort or skill applied to protect the property than the said saucepan would have received on the beach at Brighton ..."

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. The ship was called
   A. Brunel.
   B. Dundrum Bay.
   C. Great Britain.
   D. Isle of Man.

2. The ship was wrecked at
   A. Brighton.
   B. Dundrum Bay.
   C. the Isle of Man.
   D. Mourne.

3. Explain why the ship lost its way. What are the scientific principles involved?

4. This event occurred nearest to
   A. 1750
   B. 1800
   C. 1850
   D. 1900

RESEARCH QUESTIONS

5. There were two Brunels, father and son, and both were famous as engineers. Find out something more about their work. (As a hint, you may find that History teachers know more about the son than Science teachers do.).

6. How do modern ships avoid the problem mentioned in lines 10 and 11?

7. Write an essay comparing and contrasting the roles of the engineer and the scientist in scientific discovery. How do the two cooperate?

SOURCE: "Manly Daily", 5th May, 1978, p. 20. ★★★

ALGAE FUEL FOR CARS 44

A motor car which runs on fuel from algae grown commercially around the coastline is one of the many possibilities for the future according to a CSIRO scientist.

As part of their research into alternative fuels, scientists in the CSIRO division of chemical technology have been looking into the possibility of developing fuels from agricultural wastes, crops and perhaps in the future, marine plants.

Dr. Cyril Curtain said the production of fuels from these and other biological materials was already a possibility although none was sufficiently economic at present to compete with the fuels now available.

"However, by about 1985, the amount of petroleum available from Australia's known resources will have declined so much that we may be importing about two-thirds of our oil," he said

Research indicated that plant materials could potentially provide up to 60 per cent of the current needs for motor spirit - now standing at 15 million tonnes per year - if competing demands for land and food crops which they might produce, were disregarded.

These fuels could be manufactured by either fermenting or chemically coverting material from a wide range of crops including sugar cane, cassava, grains and wood.

"However, Australia's limited supplies of fresh water and the extensive sections of low-lying coastline make the commercial culture of marine fuels an attractive possibility for the future," Dr. Curtain said.

The fuels could be made chemically either by refining the oils which occurred naturally in some species of marine plants, or by fermenting the plant to make methane gas or ketones.

The CSIRO researcher said this energy farming could offer an alternative, rewarding lifestyle for those who choose other than the highly urbanised, automated society which seemed to lie ahead.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean, as they are used in the passage?

   alternative (line 7), wastes (line 11)
   potentially (line 28), current (line 30), tonnes (line 31)
   fermenting (line 36), culture (line 44), ketones (line 52)

2. What are algae (line 2)?

3. Is the heading of the newspaper report correct? If not, in what way is it misleading?

4. The scientist being reported estimated that plant materials could provide up to 60 per cent of the country's current needs for motor spirit "if competing demands for land and food crops they might produce, were disregarded." (lines 32 to 34) Is the underlined assumption justifiable now? ... in the future? Give reasons for your answers.

5. The scientist suggests that marine plants might be the most attractive sources of fuels. What reasons does he give for favouring marine plants over land ones?

RESEARCH QUESTIONS

6. What does CSIRO (line 5) mean? What does the CSIRO do?

SOURCE: Adapted from Science Journal, October, 1966. ★★

45a

LIGHT BEAM FROM SPACE MIRROR

Almost from the pages of science fiction is a proposal now under study by aerospace companies in America, for an artificial moon to illuminate selected areas of the Earth's surface at night.

To prevent the beam wandering over the face of the Earth, the reflector would be placed in geostationary orbit about 36 000 km above the equator. It would then keep pace with the Earth's rotation. Preliminary studies indicate that it would need a mirror 650 metres across to illuminate an area half the size of the state of Victoria. The mirror might be erected from a manned orbiting laboratory.

Actually, the idea of a space mirror is not new. It was first proposed by Professor Hermann Oberth in the 1920's as a method of weather control. His idea was to erect a gigantic wire net, to which would be attached thin metal foils. Oberth said that a mirror of this kind might have a diameter of many kilometres. Its component facets could be controlled by a space station.

He wrote, "this would enable large towns to get sunlight during the evening hours. The weather too could be influenced by systematic concentration of the sun's rays onto certain regions hit by drought. .....

If the mirror is made large enough, and it could be of extremely light construction, it would even appear possible to generate deadly degrees of heat at certain spots of the Earth's surface."

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? illuminate (line 2), preliminary (line 6), foils (line 13), facets (line 14), systematic (line 17).

2. The orbit of the artificial 'moon' would be such that it
   A. wandered over the face of the earth.
   B. would be controlled from a space station.
   C. would remain stationary.
   D. would stay above the same spot on earth.

3. The time it would take the artificial "moon" to complete one orbit would be
   A. 24 hours
   B. considerably longer than 24 hours.
   C. non-existent because it stays in one place.
   D. controlled by the space station.

4. The area of land which could be lit up by the artificial moon would be
   A. 36 000 kilometres.
   B. half the size of the state of Victoria.
   C. a circle with a diameter of 36 000 kilometres.
   D. 650 metres across.

5. The property of light which would be utilized by the artificial moon is that it can be
   A. dispersed.
   B. focussed.
   C. reflected.
   D. refracted.

6. The artificial moon would be used mainly
   A. to control the weather.
   B. as a deadly weapon.
   C. to illuminate the earth's surface.
   D. to eliminate droughts.

7. What does Professor Oberth mean by <u>deadly degrees</u> (line 20)?

RESEARCH QUESTIONS

8. Draw a labelled diagram to show the operation of the artificial moon.

9. Draw a diagram similar to that in (8) to show in greater detail the <u>state</u> of the reflector as it might be used
   (a) to simply illuminate a section of earth.
   (b) as a deadly heat weapon.

10. How large is half of Victoria in hectares? What radius would a circle of this area have?

SOURCE: "THE SUN" Thursday May 31, 1979, p. 26. ★★

SOLAR SATELLITES ANSWER - SCIENTISTS

46a

A U.S. scientist says two solar-powered satellites could be sent into space by 1994. These could generate as much electricity as 20 nuclear power plants.

Physics Professor Gerald O'Neill, was speaking as chairman of the fourth conference on space manufacturing at Princeton, New Jersey, recently.

"The science is sound and the engineering is practical and easily within reach," he said.

"It's time we started building the first pilot model that will lead to a clean electric energy system we can plug into."

Professor O'Neill is a long time advocate of space colony development. He also believes that the solar-power space satellites should be constructed from raw materials found in lunar rocks.

Under his plan, a small refining plant from earth would be sent into space to extract various metals and silicon from the rocks found on the moon.

The lunar rocks would be used because, due to the lower gravity on the moon, it would take only one-twentieth the amount of energy to lift materials off the moon than off our own planet, Professor O'Neill said.

This approach also helped to conserve the earth's resources.

The moon, as well as the tiny planets called asteroids, promised to contain the minerals needed to build space stations, he said.

Dr. Henry Kolm, professor at the Massachusetts Institute of Technology said: "The solar power satellite represents the only viable alternative energy source for which the technology exists now.

"You don't have to invent anything to make a solar power satellite feasible."

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do the following words mean as used in the article?

   solar (line 1), generate (line 2), pilot (line 9), advocate (line 11), lunar (line 13), viable (line 26), technology (line 26)

2. (a) What is a satellite?
   (b) Around what object or planet do you think the solar-powered satellites will revolve?

3. Why is the first pilot solar-powered satellite referred to as a model (line 9)?

4. Give *two* reasons why Prof.O'Neill believes the satellites ought to be built from material found on the moon or an asteroids.

5. What information in the article would lead you to suggest that the gravity on the moon is less than that on earth?

6. Why is it possible to construct a solar-powered satellite in the near future?

RESEARCH QUESTIONS

7. How would a solar-powered satellite work? How do you think this energy will be transmitted to Earth?

8. Why is there a *need* to set up these solar-powered satellites?

SOURCE: "New Scientist" 13th November, 1975, p.412 ★★★

47a

BLUE LOO PAPER NO THREAT TO OZONE LAYER

"Contrary to a general belief," reports the last issue of *Environmental Pollution*(vol. 9, p. 193), "the presence of dyes on toilet papers may not be a major environmental problem". For some years, water control engineers have worried that dyes released from lavatory paper might be causing a pollution hazard in surface waters. And on a more personal level, householders lacking the privilege of a connection to the municipal sewer have avoided blue paper like the plague, because the dye was popularly alleged to kill off the bacteria in septic tanks.

D. van Oevelen and colleagues from the industrial microbiology laboratory of the University of Leuven in Belgium determined to get to the bottom of the coloured tissue crisis, and subjected a variety of commercial toilet papers to a strain of the bacterium *Cellulomonas* lovingly isolated from Belgian sewage works. The papers - dyed with such agents as Pergasol Yellow, Brilliant Green, Phenamine Red, and Victoria Blue - were incubated in a reciprocal shaker at 28°C for 30 days in the dark.

Extensive tests inside this simulated sewer ended with yet another ecomyth discredited. Blue loo paper degrades no slower and no faster than any other colour. When the results of van Oevelen's research have been accepted by the environmentalist lobby (past form indicates this may take at least five years), it will no longer be possible to gauge the enthusiasm of an econut by the colour of his Andrex.

The Belgian microbiologists, however, displayed a regrettable lack of concern for the dilemmas of the socially conscious consumer, for their experiments clearly showed that some brands of toilet tissue biodegraded twice as fast as others. This variation is, they believe, a function of the original wood pulp rather than the dye. But which brand is the best buy?

Luckily, van Oevelen and his colleagues have unwittingly supplied the answer. As a control in their biodegradation tests they used Whatman No. 1 laboratory filter paper, which was gobbled up by *Cellulomonas* as fast as any commercial brand. The solution for environmentally conscious citizens is obvious, although we must warn that the comfort-characteristics of Whatman No. 1 leave much to be desired.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. In line 2, what is vol. 9, p. 193 an abbreviation for?

2. Until recently many water control engineers thought that dyes in toilet paper affected the environment. What was thought to happen?

3. Which householders avoided using blue toilet paper? Why?

4. (a) What is a bacterium (line 12)?
   (b) From where did van Oevelen and his colleagues obtain their bacterial sample?

5. (a) What is the meaning of the word incubated (line 15)?
   (b) What was the purpose of the incubation at 28°C for 30 days in the dark (line 15)?

6. (a) What is an ecomyth as used in line 16?
(b) Which "ecomyth" is being referred to in the above passage?

7. How did Oevelen's results discredit this "ecomyth"?

8. What does the author mean at the end of paragraph 3 when he says it will no longer be possible to gauge the enthusiasm of an econut by the colour of his Andrex (lines 20 and 21)?

9. (a) What does biodegraded mean (line 24)?
(b) Do different coloured papers biodegrade faster than others? If so, which?

10. (a) What is a control (line 29)?
(b) What was the control used in this experiment?

11. What does the author mean when he says The solution for environmentally conscious citizens is obvious (lines 31 and 32)?

SOURCE: Energy Life Science Library 1965. ☆★★

THE FIRST THERMOMETER 48

"About ten years ago," Daniel Gabriel Fahrenheit wrote in 1724, "I read in the 'History of Sciences' ..... that the celebrated Amontons, using a thermometer of his own invention, had discovered that water boils at a fixed degree of heat. I was at once inflamed with a great desire to make for myself a thermometer of the same sort, so that I might with my own eyes perceive this beautiful phenonmenon of nature and be convinced of the truth of the experiment."

Fahrenheit not only set out to duplicate the Amontons device, but his efforts gave mankind the first reliable thermometer and made possible the systematic study of that form of energy known as heat.

Improbable as it seems to-day, as recently as the eighteenth century, no way of accurately measuring degrees of hot and cold existed. No one could be sure of how much hotter one day was than another, except by use of his senses. A doctor had to gauge a patient's temperature by feeling his forehead, cooks had to guess the temperature of ovens. Scientists, unable to thrive in the world of guesses, were more frustrated than anyone else. They had no satisfactory instrument with which to penetrate the mysteries of heat.

Primitive efforts to measure variations between hot and cold began at the turn of the seventeenth century. As reported by one of his students, "Galileo took a glass vessel about the size of a hen's egg, fitted to a tube the width of a straw and about two spans long. He heated the glass bulb in his hands and turned the glass upside down so that the tube dipped in water contained in another vessel. As soon as the bulb cooled down the water rose in the tube to the height of a span above the level in the vessel. This instrument he used to investigate degrees of heat and cold."

A French physician, Jean Rey, inverted Galileo's arrangement by filling the bulb with water and the stem with air. He noted the expansion of the liquid as a gauge of temperature. The hands of a fever patient caused the water in the tube to fluctuate as a reflection of body heat. Although still very inaccurate, Rey's thermometer was more accurate than Galileo's.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do the words mean as used in the article?

   celebrated (line 2), phenomenon (line 6), duplicate (line 8), systematic (line 10), senses (line 14), penetrate (line 17), primitive (line 19), inverted (line 27), fluctuate (line 30).

2. How was temperature measured before the eighteenth century?
3. Why were scientists of the period particularly handicapped by the lack of a thermometer?
4. Why did Fahrenheit need to be convinced of the truth of the experiment. (lines 6 & 7)?
5. Why are scientists unable to thrive in the world of guesses?
6. Draw a diagram of Galileo's thermometer.
7. Why was Jean Rey's thermometer more accurate than Galileo's? In what ways was it still inaccurate?
8. What properties of liquids like water let them behave in the way described and so be used in a thermometer?

RESEARCH QUESTIONS

9. What is two spans (line 22)? Why is this expression used? Why did the student use "spans" instead of centimetres?
10. Two other liquids, besides water have been used in thermometers. What are they?
11. Draw and explain the parts of
    (a) an ordinary thermometer
    (b) a maximum-minimum thermometer
    (c) a clinical thermometer.

    Explain any differences.

★★

49

ANALYSING GASES

Henry Cavendish was the first scientist to collect and study gases. In the eighteenth century he gathered samples of air from all over London for comparative analysis. He also collected samples of the upper air by means of a balloon.

He is best remembered for an experiment which he did with the newly discovered *"dephlogisticated air"*. This was discovered by Joseph Priestley in 1774. "Dephlogisticated air" was being acclaimed for the "splendour" and "sparkle" with which it made things burn. Only later did Antoine Lavoisier (who was guillotined during the French Revolution) identify the substance and name it oxygen.

Cavendish burned carefully measured amounts of this 'new air' oxygen together with hydrogen. He found that the two gases were completely converted to their own weight of water. This was the first quantitative proof that water was a compound of hydrogen and oxygen.

In France, Lavoisier repeated the experiment and also reversed the process by decomposing water into the two gases. He also showed that water could be vaporised into steam, then recondensed with no change in weight. Lavoisier took the results of these experiments to support his cardinal principle that in chemical reactions, matter, whether solid, liquid or gas, is neither created nor destroyed. He supplemented this theory by exhaustive studies on the combustion of various substances, and by research on fermentation and putrefaction.

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1. What do these words mean as they are used in this article?
   comparative (line 3), analysis (line 3), acclaimed (line 7), quantitative (line 13), compound (line 14), decomposing (line 16), supplemented (line 20), exhaustive (line 20), fermentation (line 21), putrefaction (line 22).

2. How did Lavoisier's experiment with the "new air" go further than Cavendish's experiment?

3. What was Lavoisier's "cardinal principle"? By what name do we know it today?
   What are the meanings of the words cardinal and principle in this context?

4. Write word equations and balanced chemical equations for the experiments performed by Lavoisier as described in the passage.

RESEARCH QUESTIONS

5. What is "dephlogisticated air" (line 6)? Write a brief account of its discovery.

6. Why was Lavoisier guillotined in the French Revolution?

7. What were the dates of birth and death of Cavendish, Priestley, and Lavoisier? Give this information for 5 other famous scientists who lived in the same century.

★★

SOURCE: Adapted from "The Scientist", LIFE SCIENCE LIBRARY, 1972 p.88.

50

PHYSICS

Physics, the most basic of the natural sciences, seeks to establish mathematical laws to explain and predict the behavior of mass and energy. Matter had been studied since very ancient times, but modern physics did not come about until the end of the nineteenth century.

Four apparently unrelated branches of science fused together forming the foundation of physics as we know it now. These branches were:- *mechanics*, the study of motion; *optics*, the study of the properties of light; *thermodynamics*, the study of heat and *electromagnetism*, the study of electric and magnetic forces.

During the nineteenth century, these four fields began to show things in common. Heat was recognised as being due to the movement of particles. Light was found to be an electromagnetic wave. Electro-magnetic waves, in turn, were found to behave like some mechanical systems. These resemblances were explored by some of the best minds in the history of science, and soon modern *"physics"* exploded into being.

No other science to date has experienced such successes. In the next seventy years, physics grew and grew. New branches appeared everywhere. Atomic physics gave rise to quantum mechanics, solid state, molecular and nuclear physics. These have produced particle and plasma physics, relativity and many more startling new physical and philosophical ideas.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as they are used in the article?
   predict (line 2), matter (line 3), fused (line 5), foundation (line 6), properties (line 7), in common (line 11), resemblances (line 14).
2. Which branches of science formed the foundation of physics?
3. What is the relationship between thermodynamics and mechanics.

RESEARCH QUESTIONS

4. The passage mentions 12 different branches of physics. List these and 3 other branches in a table along with a very brief statement of what each is about.
5. Name a famous physicist from each of the following times in history and give a one paragraph account of their contribution to physics
   a) before 1700 b) 1700 - 1900 c) 1900 - present
6. The word systems (line 13) can be used in various ways in science. Give an example of the word "system" as it might be used in physics, chemistry, geology and biology.

SOURCE: Adapted from "The Scientist", Life Science Library, 1972. p.90.

★★

CHEMISTRY 51

Chemistry is the science that investigates the properties and reactions of substances. It had its origins in the laboratories of the alchemists. Alchemy eventually disappeared as "science" gained a foothold in society, but its tools and methods remained. It was followed by the new study of medical chemistry. Men such as Paracelsus and Van Helmont gained shrewd insight into chemical laws as they attempted to find cures for bodily ailments. Lavoisier's provocative experiments with combustion in the 1700's completed the transformation of chemistry into an exact science.

Most of the knowledge gathered by early researchers was in the field of inorganic chemistry. As late as the 19th century, chemists believed that a mysterious "vital force" was needed to make organic compounds. These are the compounds made by living things. They all contain the element carbon, as well as hydrogen and oxygen.

In 1828 however, Friedrich Wohler made an organic compound in a simple laboratory experiment. This opened the door to this branch of chemistry and its compounds are among our most useful chemical products to-day. Their recent popularity has largely been due to a new process discovered by chemists. This type of reaction, "polymerization"has enabled chemists to produce new, tailor-made molecules These are linked together to make plastics, textiles and medicines.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS

1. What do these words mean as they are used in this article? properties (line 1), reactions (line 1), alchemists (line 2), foothold (line 3), compounds (line 12), molecules (line 19).
2. How did the study of chemistry begin? Define any terms you use.
3. What was the *supposed* difference between an organic and an inorganic chemical?
4. What is the difference between an organic and an inorganic chemical?
5. What is meant by the term linked together (line 19)?

RESEARCH QUESTIONS

6. What is an exact science (line 8)? Why was chemistry not an exact science before Lavoisier?
7. Describe, in more detail than that given in the passage, the meaning of polymerization (line 18). Give 3 examples of polymerization.
8. Write a short account of Lavoisier's famous work on combustion. What impact did this have on the study of chemistry?

SOURCE: "The Scientist", Life Science Library. ★★

LIFE SCIENCE 52

The study of living things began with early man's concern for his health. He studied herbs for their medicinal value and learned some things about his body from his primitive attempts at therapy. The Greeks took this simple body of knowledge and vastly enlarged it. They based much of their medicine on sound natural sciences. Aristotle's speculations about natural things led him to pioneer in botany, zoology and embryology.

The development of the microscope in the seventeenth century led to microbiology. This later gave rise to histology, the study of tissues, and cytology, the study of cells.

As a result of recent discoveries in cytology, biologists throughout the world are foretelling a new era in biological studies. The molecular structure of DNA has been analysed. This chemical is the substance in cell nuclei that determines genetic characteristics of all living creatures. The processes by which DNA governs cell specialization are becoming better understood. The study of DNA and other cell molecules have given rise to the field of molecular biology.

This is probably the most exciting field of study in modern science to-day. Through it scientists may one day understand the chemical basis of life - may solve living things to chemical specification.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

QUESTIONS.

1. What do these words mean as they are used in the passage?
   (a) therapy (line 4) (b) natural (line 5)
   (c) molecular (line 13) (d) new era (line 12)
   (e) specification (line 16)
2. How did life sciences begin?
3. What event occurred to greatly assist and enlarge the study of life sciences?
   When did this occur?
4. Seven "branches" of life sciences are mentioned in the passage. Record them, and three more. What does each "branch" study?

RESEARCH QUESTIONS

5. Briefly describe what is meant by genetic characteristics (lines 14 & 15). Show, using relevent diagrams, how these are passed from generation to generation.
6. What is cell specialization (line 16)? Give 3 examples to illustrate your explanation.
7. Write a few notes on D.N.A. What exactly is it? Who discovered it? Who worked out its structure? What does it do?
8. Who invented the first microscope? When? Draw (or obtain) a labelled diagram of this first microscope and compare it with the ones you have used in your science course.
9. What is exciting about molecular biology? Explain what it is. What modern advances have been made in life science because of its discoveries in molecular biology?

SOURCE: Science Journal January 1969.

WASTE PACKAGES

53

The removal of waste package material has posed problems in recent years. A solution has been proposed by the Eastman Kodak Company.

They propose making certain items from a substance which will disintegrate on exposure to sunlight. They have found that packages made from the substance will decompose and be blown away as powder within a few days.

The basic materials used are ethylene and carbon monoxide. The time taken for the package to decompose depends on the proportion of carbon monoxide in the mixture.

The main application is thought to be drinking cups, and sandwich wrappers. It could also be used with delayed feeding arrangements for farm animals. The animal food is wrapped in the substance and placed at feeding spots on the farm. Only after several days exposure to sunlight will the food become available to the animals.

A further aspect of the invention involves cups in drink dispensing machines. Some unscrupulous vendors refill these machines with non-sterile used cups. However, cups made from the new material will distort sufficiently after a few hours so that it will be impossible for this to happen.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the passage? posed (line 1), disintegrate (line 4), proportion (line 8), application (line 10), aspect (line 15), unscrupulous (line 16).

2. What affects the rate at which the packages decompose? The
   A. intensity of the sunlight falling on the package.
   B. amount of sunlight falling on the package.
   C. proportion of carbon monoxide in the mixture.
   D. temperature and amount of wind.

3. Which of these uses would NOT be suitable as an application of the new substance?
   A. Delayed feeding for dairy cattle.
   B. Disposable drinking cups.
   C. Reusable cups for picnic sets.
   D. Lunch wrappings.

4. Why do so many substances used for packaging pose waste disposal problems? Because
   A. there are so many packages used.
   B. they might be re-used in drink machines.
   C. they decompose after several days in the sun.
   D. they do not disintegrate easily.

RESEARCH QUESTIONS

5. List 5 other uses to which the new sustance might be put. List 5 situations in which it would be unsuitable to use the new substance.

SOURCE: Adapted from Science Journal, August 1966. ★★

IS ASBESTOS A PUBLIC HEALTH HAZARD? 54a

Concentration of asbestos particles in the air may prove to be one more hazard of urban living. Studies by scientists in many parts of the world have shown a higher than normal death rate among asbestos workers from certain kinds of cancer. They also show a higher amount of asbestos particles in the lungs of these workers. Now the question is - does asbestos present a *public* health hazard?

Autopsies on 500 previous residents in a large American city found asbestos particles in the lungs of 30% of the males and 20% of the females. These findings are similar to those found in an earlier survey in Cape Town, South Africa. The researchers pointed out that none of the deaths was attributed to any kind of lung disease. They found that only a few males had what might be considered a significant concentration of asbestos in their lungs. Their survey showed only that urban dwellers are exposed to some asbestos inhalation.

The use of asbestos has increased greatly in the past 30 years. It is used in houses, plastics, paper and beer production, brake linings and dental cement. It is very resistant to corrosion, heat and wear. These are properties which make asbestos valuable but also make its accumulation in the environment inevitable.

The most common form of asbestos has a tendency to break into hair-like fibres. These fibres, when inhaled get caught in the lungs and may be the cause of future cancers and other lung diseases.

An earlier study commented that asbestos workers have six to seven times the normal death rate from lung cancer. They also have about three times the normal death rate from cancers of the stomach, colon and rectum. The study said that "Asbestos is now a hazard in an increasing variety of occupations involving asbestos or asbestos-containing materials."

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? hazard (line 2), autopsies (line 7), significant (line 13), inhalation (line 15), corrosion (line 18), valuable (line 19), accumulation (line 20), colon (line 27).

2. Asbestos gets caught in lungs when inhaled because it
   A. resists corrosion.
   B. does not decompose easily.
   C. accumulates in the environment.
   D. forms hair-like fibres.

3. Asbestos accumulates in our environment because it
   A. is used in many products used by man.
   B. has been used extensively since 1935.
   C. is involved in a increasing variety of occupations.
   D. is not easily broken down.

4. What were the results of the survey conducted on American city dwellers?

5. What is the implication in the article? (What message is it trying to put across?)

RESEARCH QUESTIONS

6. Do some research and list as many asbestos containing products used by man as you can. How many substances in your home contain asbestos?

7. Describe the properties that asbestos has which cause it to be easily *inhaled*, and to become easily and permanently lodged in lung tissue.

★★★

SOURCE: Adapted from "Scientific American", February 1979, p. 27

55a

DIOXIN

The molecule nicknamed dioxin, whose proper title is *2,3,7,8 - tetrachlorodibenzo - para-dioxin* (acronym *TCDD*), is not a very complex substance. The molecule's pattern is neat but its work is deadly. A fatal dose of such powerful agents as heroin or cyanide for a person of normal size has about the bulk of half a tablet of aspirin. Dioxin is more toxic by a rough factor of 100, the most poisonous small molecule we know.

It is a synthetic product derived from the production of the widely used herbicides *2,4-D* and *2,4,5-T*. From 1949 on there have been severe accidents in five countries during industrial preparation of the herbicides; several hundred workers having been affected as a consequence. What substance was to blame became known only in 1957. A German chemist entered into hospital for treatment of his extreme case of acute acne with pustules forming at all the little oil glands around the hair follicles of the skin. He was at the very Hamburg hospital where, a few years before, a number of chemical-factory workers had appeared with the same affliction. The identification was confirmed.

The substance has many effects. Acne arises from contact, even in rabbits, and the stuff is fatal to rats in a single oral dose; the animals show little interest in food and waste away in a month. At postmortem the most striking finding is a loss of body fat. In fact, in many animals it is difficult to find enough remaining fat for analysis.

Dioxin has been spread far and wide, in low concentrations to be sure, over the U.S. and Vietnam. *Agent Orange*, a much used defoliant for weeds and forest cover, seems to have had an unwanted and often unknown contamination of dioxin since it was first made. The Air Force delivered from the air about 40 000 tonnes of *Agent Orange* to the forested roadsides of Vietnam. Dioxin was often there in concentrations well below 1 part in 10 million.

Photodegradation by solar ultraviolet radiation and decomposition by soil microorganisms do slowly remove the danger.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What is the meaning of the following words as used in the article?
   acronym (line 2), fatal (line 4), toxic (line 6), synthetic (line 8), derived (line 8), herbicides (line 11), pustules (line 14), affliction (line 17), defoliant (line 24), contamination (line 26), photodegradation (line 30).

2. Why is dioxin not referred to by its proper title?

3. What does the author mean by the molecule's pattern is neat (line 3)?

4. About how many people of normal size would be killed by a dose of dioxin with the same mass as an aspirin tablet?

   A. 0 B. 1 C. 100 D. 200

5. How was dioxin first discovered?

6. What symptoms does dioxin poisoning cause in man?

7. What does dioxin do to rats and rabbits?

8. Since dioxin was found to be present in herbicides sprayed on pastures and crops, a careful study is being made of the quality of mother's milk. Why is this study being carried out?

RESEARCH QUESTIONS

9. If Agent Orange contains 1 part in 10 million of dioxin, calculate the number of kilograms of dioxin spread over Vietnam.

10. Find out more about the herbicides 2,4-D and 2,4,5-T. Why are they used on pastures and crops?

★★★

SOURCE: "Scientific American", November 1978, pp. 81A and 81B.

THE DISCOVERY OF PENICILLIN

56a

In 1896 the antibacterial action of *Penicillium* was unmistakably demonstrated by a 21-year-old French medical student named Ernest Augustin Clement Duchesne. Duchesne's pioneering work was ignored by his contemporaries, and his discovery was forgotten for 50 years ....

He knew that if a single spore of mould fell onto a damp piece of bread, rotten fruit, cheese or jam, a thick growth of mould would appear within a few days. In other places where moulds might be expected to thrive, however, they were usually absent. For example, although mould cells were extremely prevalent in the air, they were hardly ever seen under the microscope in water that had been added to cultures of bacteria ....

Initially Duchesne found that the presence of bacteria in which mould was growing usually led to the rapid destruction of the mould. He asked himself, however, whether in the struggle for existence between moulds and bacteria there might not be certain conditions in which the mould would prevail. In one experiment he cultivated *Penicillium* on a piece of moist food and transferred *Escherichia coli* bacteria onto the mould. After a few hours he examined the mould and found that the bacteria had been killed.

His next step was to inoculate guinea pigs with virulent cultures of pathogenic microorganisms such as *E. coli* and typhoid bacteria. Then he injected half of the animals with nutrient broth on which *Penicillium* had been grown. The next day the animals that had received the injection of broth were alive and healthy but the animals that had not received it were dead. Apparently the growth of the bacteria in the animals had been inhibited by the crude extract of the mould represented by the broth ....

Duchesne's findings attracted no attention until his thesis was accidentally discovered by a librarian some 50 years after he had completed his experiments. As is the case with many other discoveries that were anticipated, it is not known why his work was ignored by the microbiologists of his time ....

For their work on penicillin Fleming, Chain and Florey shared the 1945 Nobel prize for physiology or medicine. In September of that year Fleming gave a speech at the Academy of Lyons and mentioned the work of Duchesne, which by that time was known to him. He said that whereas he had noticed the antibacterial effects of *Penicillium* by chance, Duchesne had done so by methodical investigation. Fleming's contribution was nonetheless the crucial one. As Francis Darwin, the botanist son of Charles Darwin, observed: "In science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs."

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the passage? prevalent (line 10), prevail (line 17), cultivated (line 17), virulent (line 21), inoculate (line 21), pathogenic (line 22), inhibited (line 27), crude (line 27).

2. Why is the expression "crude extract" (lines 27 and 28) used?

3. What is the difference between "physiology" and "medicine" (line 35)?

4. How much of the last paragraph is a summary of Fleming's speech at Lyons? (Do you think Fleming made the comments in lines 39-42, or is that the author of the article?) Indicate your reasons.

5. List the main steps by which Duchesne arrived at his discovery that *Penicillium* can inhibit the growth of bacteria in animals.

RESEARCH QUESTIONS

6. Why should the work of Duchesne have been rediscovered when it was?

7. What were the parts played by each of Fleming, Chain and Florey in the development of penicillin?

8. Why might Francis Darwin have made such a comment as that found in the passage?

9. What are some of the "many other discoveries that were anticipated" (lines 31 and 32)?

10. Is it fair to say that Duchesne discovered penicillin? Why?

11. Duchesne was probably lucky to get any results at all. Find out why this is so.

SOURCE: Science Journal June 1967. ★★

PLASTIC SURGICAL TOOLS

57a

A complete new range of surgical instruments has been developed in West Germany. The instruments have been made from a plastic known as ultramide. This material was chosen so that the new instruments can be sterilized by conventional methods. The first tests have shown that the properties of ultramide have a number of distinct advantages compared to the steel used at present.

The plastic material is more elastic. This reduces the danger of unintentional damage to tissue and organs during an operation. It also has a low thermal conductivity. This lessens the chance of cold shocks. They are also transparent to x-rays. This eliminates disturbing shadows which are produced on x-rays taken during an operation by metallic instruments. These occur because metals are not transparent to x-rays. Another advantage is that the plastic instruments do not slip on body tissue. Metal instruments like forceps, have to be bound in muslin before use to stop them slipping. As this no longer has to be done, time will be saved.

Apart from these operational advantages the instruments can be packed in sterile packages. They will always be ready for emergencies. The plastic instruments will also be cheap enough to be able to be dispensable.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the article? developed (line 1), sterilized (line 4), distinct (line 5), unintentional (line 8), thermal (line 9), muslin (line 15), dispensible (line 20).

2. The word conventional (line 4) has several meanings. In this article it means

   A. acceptable.
   B. common.
   C. convenient.
   D. usual.

3. What do the words disturbing shadows (line 11) mean? Why is the word "disturbing" used?

4. What property of the ultramide reduces the occurrence of shock in patients?

5. Why will the new instrument be an advantage in an emergency situation?

6. What is meant by the term not transparent to x-rays (line 13)?

7. What do you think would be the actual benefit of the plastic material being more elastic (line 7)? What is the scientific meaning of the term 'plastic'?

RESEARCH QUESTIONS

8. How are surgical instruments sterilized usually? How are they kept sterile? Who first discovered the sterilization process? When?

9. Look up a medical book and find the shape and use of five surgical instruments. Draw these and note their particular uses.

SOURCE: Science Journal, November 1966. ★

LIFE-LIKE DUMMY 58a

A life-like dummy that reacts to anaesthetics has been designed in the United States. The dummy reacts to anaesthetic just like a human. It will be used at the Los Angeles County General Hospital by medical students from the University of California. Scientists from the University were responsible for its design.

The dummy is the most complex medical simulator yet devised. When placed on an operating table it will be connected to a computer. It will be sensitive to ten different drugs, will breathe and have a heartbeat and pulse.

It can also open its mouth, stick out its tongue, wrinkle its eyebrows and cough. It can extend and relax its vocal cords, twitch its shoulder muscles and change colour fron pink to blue to ashen grey. The instructor will be able to control the dummy to simulate emergency situations. For example, it can imitate a heart attack to test student reactions to an emergency situation.

The dummy will be built by the Sierra Engineering Company, California. This firm specialises in making experimental dummies. The instrumentation will be made by the Aerojet-General Corporation.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

What is the meaning of these words as they are used in the article?

(1) simulator (line 6)

A. model used for operations.
B. device to imitate real events.
C. machine made by engineers.
D. print-out device used with computers.

(2) sensitive (line 8)

A. able to measure accurately.
B. composed of soft materials.
C. will react with.
D. able to detect.

(3) specialises (line 18)

A. makes the dummies very well.
B. makes only these dummies.
C. makes lots of different dummies.
D. concentrates on making dummies.

(4) The purpose of the dummy is to

A. determine its reaction to different drugs.
B. give medical students operating practice.
C. imitate heart attacks in patients.
D. test student reactions to emergencies.

(5) The dummy must be able to do so many things so it can

A. imitate as many emergencies as possible.

B. react differently to different drugs.

C. produce realistic reactions in an emergency.

D. look as life-like as possible.

(6) Find some other situations in which researchers use dummies in the place of humans. Why are these dummies used?

SOURCE: Science Journal, October, 1970 ★★

SUTURE REDUCES EFFECTS OF OPERATIONS 59

Scientists in England have developed a new synthetic soluble suture. The new stitching material is known as Dexon. Its main advantage is that it is completely absorbed into the body and therefore causes no adverse tissue reaction. Conventional sutures do not do this.

The suture is highly efficient because it is absorbed into the body at a uniform rate. It also retains its strength for 15 days after use. This is the crucial wound healing period. Further, body tissue does not react with Dexon, so there is no inflammation of the wound nor associated pain. There is also very little scarring after the incision has healed.

Scars form because the body tissue reacts against the materials used in the stitches. This includes catgut, cotton, silk and nylon - the traditional materials. These substances are foreign to the human body so it reacts against them.

The new suture is made from polyglycolic acid. Since glycolates naturally occur in the body, the Dexon suture is fully compatible with human tissue.

Instead of producing a tissue reaction, the polyglycolic acid suture reacts with water. It is absorbed into the tissue and eventually eliminated from the body in urine.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the passage? synthetic (line 1), soluble (line 1), absorbed (line 3), suture (line 5), uniform (line 7), inflammation (line 10), compatible (line 17).

2. Why are the materials referred to in line 14 referred to as traditional materials?

3. Why does scarring usually occur around an incision?

4. Explain the meaning of the term poly as it applies to polyglycolic acid (line 16).

5. What would be the effect of a daily shower on your unbandaged appendix stitches.

RESEARCH QUESTIONS

6. What is polyglycolic acid (line 16)? Why are glycolates present in our bodies?

7. Show using a diagram the kind of chemical process which occurs as the Dexon reacts with water. Label any important aspects of your diagram.

8. Why are catgut, silk, nylon and cotton used in surgery?

SKIN CANCER ON INCREASE

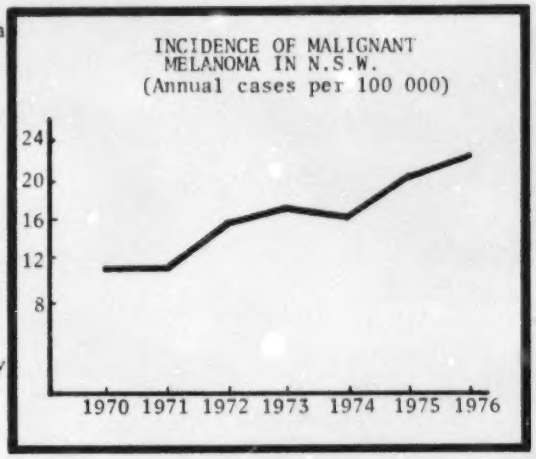
The incidence of melanoma, the most dangerous form of skin cancer, has about doubled in N.S.W. in recent years, according to a new survey.

Melanoma usually results from malignant changes to a mole. About a third of the people who suffer it are dead within five years.

The survey seeks to present a more accurate picture of the disease than previously available. It shows that 1 091 cases of melanoma occurred in N.S.W. in 1976 compared with 532 in 1970.

The incidence of the disease rose from 11.4 to 22 per 100 000 of population over the same period.

The survey leader, Professor W.H. McCarthy, said yesterday that the incidence of melanoma was rising world-wide.



But no previous study had reported a doubling of the rate in seven years. The rising incidence was likely to apply throughout Australia.

Professor McCarthy, an associate professor of surgery at Sydney University, offered these possible explanations for the increase:

It *might* reflect the continued Australian tendency to equate health with suntan, leisure with surf, beach and outdoor activities and tanned skin with sex appeal.

Most of the patients in the study were born after the turn of the century and had shared in an era of increasing affluence and leisure time.

It *might* reflect increasing ultra-violet radiation in sunshine. This may be due to increasing destruction of the ozone layers of the atmosphere by high-flying aircraft and fluoro-carbon aerosols.

Melanoma and other skin cancers are known to be associated with the intensity of ultra-violet radiation.

A logical next step would be to analyse the changes in ultra-violet levels over the period.

It *might* be the culmination of increasing exposure to environmental pollutants. These include known cancer-producing agents such as photo-chemical smog, petrol fumes and tobacco.

The patients studied had lived in an environment of increased industrial activity and an area of rapidly rising environmental pollution.

Professor McCarthy presented the survey findings at an epidemiological conference in Sydney.

He decided on the survey because of the number of cases referred to the melanoma unit. Also, a general impression among concerned doctors suggested that the real incidence of melanoma was considerably higher than reported.

The number of cases was calculated by contacting the specialists who rule on whether a growth is cancerous - 59 Government and private pathologists in N.S.W.

Professor McCarthy said the rise in melanoma revealed by the study requires further urgent investigation.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do the following words mean as used in this article?
incidence (line 1), malignant (line 4), equate (line 26), affluence (line 30), radiation (line 32), intensity (line 36), culmination (line 39), epidemiological (line 44), pathologist (line 52).

2. The following phrases appear in the article. Explain what they mean in your own words.
(a) fluoro-carbon aerosols (line 34)
(b) ultra-violet radiation (line 36)
(c) environmental pollutants (lines 39 and 40)
(d) photo-chemical smog (line 41)

3. This article was written
A. in 1970
B. between 1970 and 1976.
C. in 1976
D. after 1976.

4. Of the 532 cases of melanoma reported in N.S.W. in 1970, about how many would you not expect to be living in 1976.

5. There were 1091 people in N.S.W. who had melanoma reported in 1976. How many of these would you expect to be still alive in 1981.

6. (a) Give *three* possible explanations for the increase in melanoma in recent years.
(b) Why are these called "possible explanations"?

7. What do you think might be a function of the ozone layers in the upper atmosphere?

8. Why did Professor McCarthy do the survey?

9. What do you think is meant by the statement at the end of the article that the increased incidence of melanoma will need "further urgent investigation"?

10. Professor McCarthy found that the older the person the greater was the chance of getting melanoma. Suggest a possible reason for this.

11. Professor McCarthy also found that between 50 and 70 years of age the chance of men getting melanoma rose steeply but the chance of women dropped. What might account for these facts?

12. From the graph work out the number of cases (per 100 000) of melanoma reported in (a) 1971; (b) 1973); (c) 1975.

13. (a) Carefully copy the graph into your book. Extend your graph to cover the period between 1976 and the present.
(b) From your graph, about how many cases of melanoma per 100 000 people will be reported this year?

14. (a) What is the population of N.S.W.?
(b) Using your answer from the previous question, how many people in N.S.W. will contract melanoma this year?

★★★

Source: "Scientific American", December 1975: "Science and the Citizen".

WARNING: THIS METHOD IS NOT RECOMMENDED IN AUSTRALIA FOR SAFETY REASONS.

LIFESAVING PUNCH

61a

The list of first-aid procedures that the medical profession encourages laymen to undertake is short because of the profession's concern that tactics applied in ignorance may do more harm than good. Now, however, the Commission on Emergency Medical Services of the American Medical Association has cautiously endorsed the "Heimlich manoeuvre" as a first-aid procedure when someone is choking on a foreign object ...

In the Heimlich manoeuvre you put the thumb side of your fist or the heel of your palm against the victim's upper abdomen, between the navel and the bottom of the rib cage, and make a quick upward thrust. The action elevates the diaphragm, thereby compressing the lungs and forcing air up through the trachea. The air expels the foreign object. Heimlich recommends the fist method if the victim is standing or sitting; get behind him and wrap your arms around his waist, so that you can apply the strength of both arms to the upward thrust. If the victim has collapsed, put him on his back, kneel astride his hips, put the heel of your palm against his abdomen, and then push upwards with both hands. Repeat several times if necessary. If you are the victim, use the fist method on yourself.

Heimlich writes that since he first described that technique he has heard of 162 people whose lives were saved by the manoeuvre and that "no instance has been reported where the manoeuvre was not successful".

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean as they are used in the article? laymen (line 2), endorsed (line 5), abdomen (line 9), elevates (line 11), compressing (line 11/12), trachea (line 12).

2. Who invented this method? What evidence are you using?

3. Why does the medical profession believe that tactics applied in ignorance may do more harm than good (lines 3 and 4)?

4. Why is it suggested that people use the fist method on themselves (lines 19 and 20)?

5. Draw a diagram to show the positions of the hand or hands, the diaphragm, the lungs, the trachea and the mouth.

6. What is the meaning of the expression choking on a foreign object (line 7)? What does foreign mean in this article?

RESEARCH QUESTIONS

7. The word laymen (line 2) did not always mean what it does now. Find out what it used to mean, and try to explain the change.

8. Find out why the Heimlich manoeuvre is not recommended in Australia.

9. Why is the manoeuvre only cautiously endorsed (line 5)?

10. Does the last paragraph prove that the Heimlich manoeuvre is safe? What is proof?

★★★★

SOURCE: Frank W. Dobbs : "The age of the Molecule" Harper and Row, 1976.

EQUILIBRIUM : THE MORE THINGS CHANGE, THE MORE THEY STAY THE SAME **62a**

Let us now consider the chemical reaction,

$$H_2 + Br_2 \rightarrow 2HBr$$

This reaction is reversible. Not only do H_2 molecules react with Br_2 molecules to form HBr molecules, but HBr molecules react with each other to form H_2 and Br_2. Because both the forward and reverse reactions occur, the reaction never comes to completion: That is, a point is never reached at which there is no H_2 or Br_2 (or, if we consider the reverse reaction, no HBr). A point called equilibrium is eventually reached, however, when no further change in the concentrations of Br_2, H_2, or HBr occurs. Equilibrium is reached not because both forward and reverse reactions stop (which never happens), but because they effectively cancel each other out. In other words, equilibrium for the above reaction will be reached when the reverse reaction uses up HBr molecules at exactly the same rate as the forward reaction produces them. If, for example, the forward reaction produces 1 000 000 HBr molecules in 1 second and if in that same 1 second 1 000 000 HBr molecules are used up in the reverse process, the number of HBr molecules will not change. At equilibrium there is no net change; the concentrations of all the substances remain the same.

Just because a reaction mixture is at equilibrium does not mean that there are equal amounts of reactants and products; in general there will be much more of one than the other. We use the term position of equilibrium to indicate which substances are favoured under equilibrium conditions. With the above reaction, for example, if we said the position of equilibrium was to the right it would mean that when the reaction mixture had come to equilibrium there was much more HBr than H_2 or Br_2. If, on the other hand, the position of equilibrium was said to be to the left it would mean that there was more H_2 and Br_2 than HBr present at equilibrium.

Do not write any answers on this sheet. All answers are to be written on your own paper or in your book.

1. What do these words mean, as they are used in the article? reversible (line 3), equilibrium (line 8), concentrations (line 10), reaction (lines 14, 15, 16).

2. What does it mean to say substances are favoured (line 24)?

3. If the equilibrium position in the reaction (line 2) was to the left, there would be
   A. less bromine and more hydrogen.
   B. more bromine and less hydrogen.
   C. more bromine and more hydrogen.
   D. more hydrogen bromide.

4. In the reaction (line 2), what are the reactants and products (line 22)?

RESEARCH QUESTIONS

5. Some reactions are more easily reversed than others. Give two other examples of chemical reactions which are easily reversed.

6. A number of factors affect the position of an equilibrium in a reversible reaction. Other factors don't. From the list below write down those that do affect equilibrium.
agitation of mixture, catalyst, concentration of the reactants, concentration of the products, size of solid particles, pressure, shape of the container, temperature.

7. Select one of the above factors which affect equilibrium and briefly discuss it in more detail.

★★★

STEAM ENGINES

63

In 1824 Nicolas Carnot published a paper called "Reflections on the Motive Power of Heat." In the paper Carnot pointed out the importance of the world's fast-developing industrialisation, and the role of the steam engine in this. He noted that the efficiency of the steam engine has been improved and wondered how far this improvement could go.

"The question has often been raised", he wrote, "whether the motive power of heat is unbounded or whether the possible improvements in steam engines have a limit, which the nature of things will not allow to be passed."

In addressing this problem, Carnot took a careful look at steam engines, asking what really happens in them. He observed that their action is a cyclic process. First water is heated. This turns to steam. The steam expands in the cylinder and does mechanical work by pushing the piston. Then it goes to a cold condenser, Here it turns to water again and is returned to the boiler.

Carnot reasoned that existing steam engines were inefficient mainly because of the leakage of steam and friction of the piston. He imagined an ideal heat engine with no thermal or mechanical defects. He conceived it merely as a cylinder fitted with a leak-proof frictionless piston. The cylinder was perfectly insulated and the heat needed to make the steam was allowed to pass freely through the base.

One full cycle of this perfect engine would include heating the water, letting the piston rise under steam pressure and returning the piston to its orginal position by condensing the steam.

In the course of studying the cooling cycle Carnot realised that some heat loss was *necessary* for the operation of any steam engine. Once the piston was raised by the steam it would be impossible to get it back down without taking the steam out of the piston chamber and condensing it. In this condensing process, some heat must be lost.

DO NOT WRITE ANY ANSWERS ON THIS SHEET. ALL ANSWERS ARE TO BE WRITTEN ON YOUR OWN PAPER OR IN YOUR BOOK.

1. What do these words mean as used in this article?

   motive (line 2), efficiency (line 4), addressing (line 11), friction (line 18), ideal (line 19), conceived (line 20), insulated (line 21), condensing (line 30).

2. What are thermal (line 19) and mechanical defects (line 19) in general? What are they when specifically referring to a steam engine?

3. How does a steam engine work? Draw a simple diagram of a steam engine using the information supplied in the passage.

4. What is a cyclic process (line 13)? How is the 'steam engine' a cyclic process?

5. Why must heat be lost (line 30) in the condensing process?

RESEARCH QUESTIONS

6. Decribe 3 other cyclic processes. Labelled diagrams may be used.

7. When was the first steam engine invented? Who invented it? What was early steam engines used for? What are steam engines used for to-day? Why are there fewer steam engines to-day compared to earlier days? Is this going to be a continuing trend?

8. If the world is suffering an energy crisis why not convert our machines back to steam power? Would this solve the problem? Explain why.